AGRICULTURAL ENGINEERING

NOVEMBER • 1951

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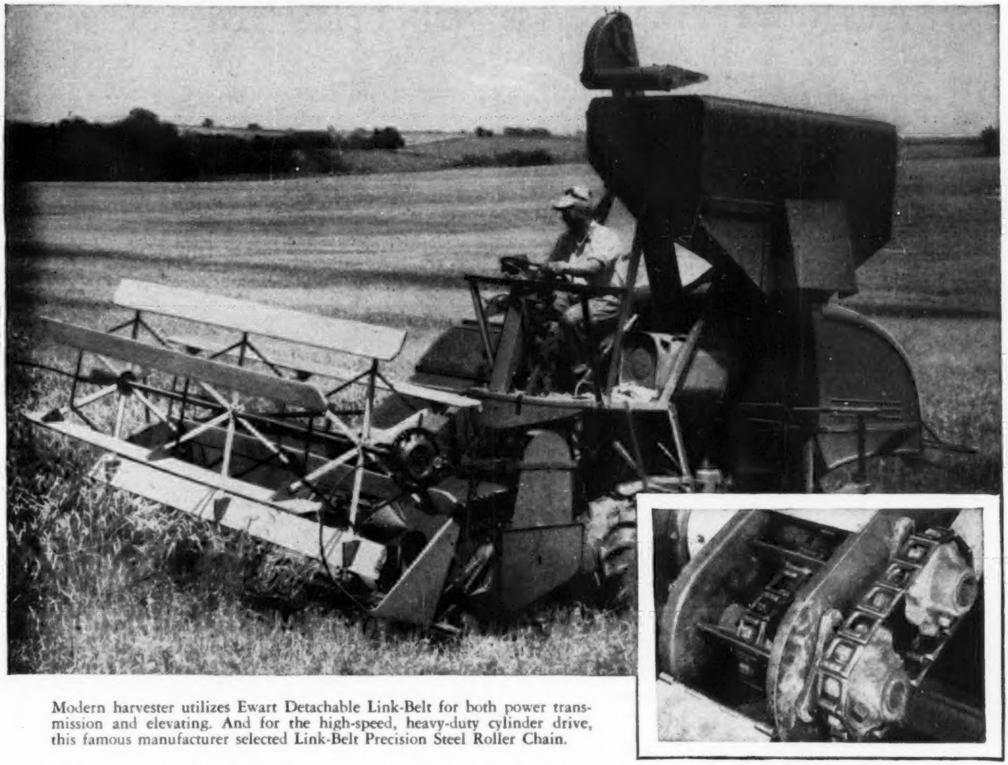

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AGRICULTURAL ENGINEERING

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CONTENTS FOR NOVEMBER, 1951

Vol. 32, No. 11

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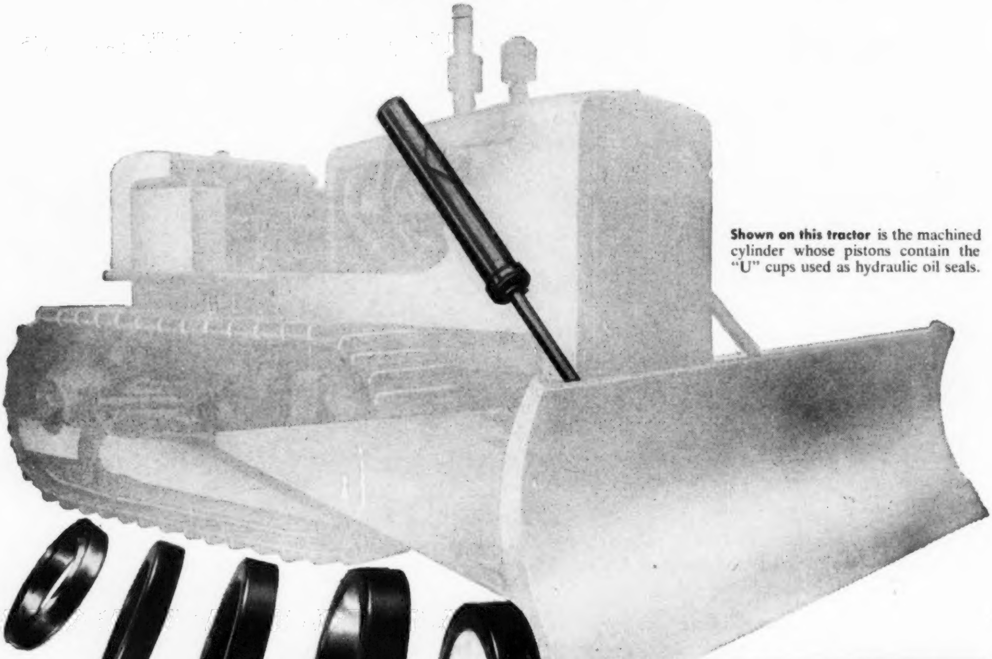
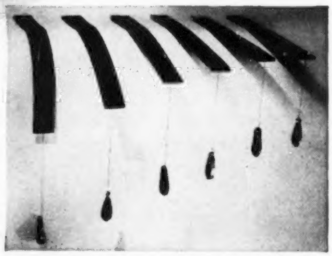
What's U. S. Rubber doing with hydraulic oil seals?



Shown on this tractor is the machined cylinder whose pistons contain the "U" cups used as hydraulic oil seals.



"U. S." is making hydraulic oil seals do a better job by constructing them of Enrup, a thermosetting plastic compound fabricated and molded entirely by United States Rubber Company engineers. Five sizes of this seal are being used on machined cylinders on tractors and other heavy road-building equipment. These seals last much, much longer than the seals previously used.

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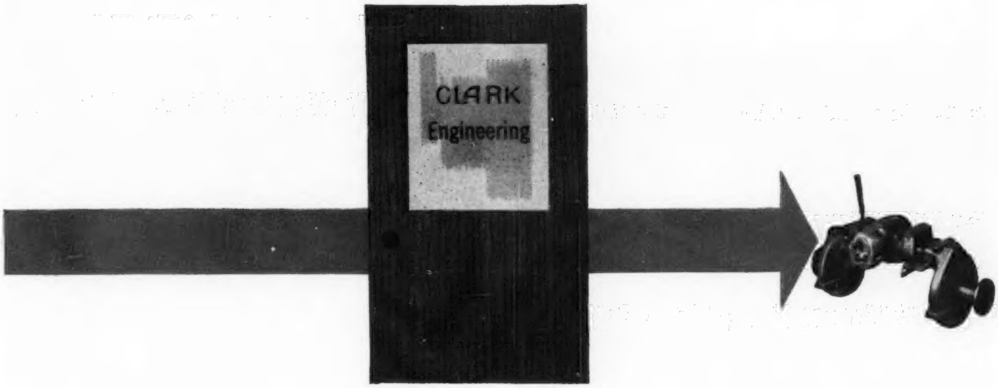
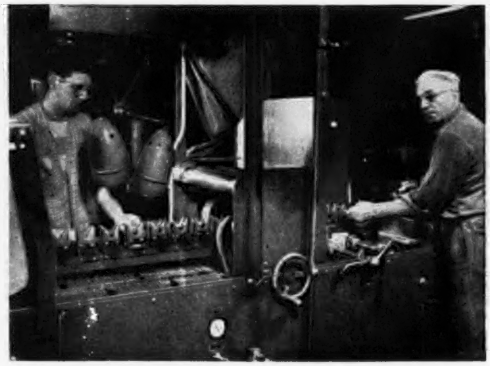
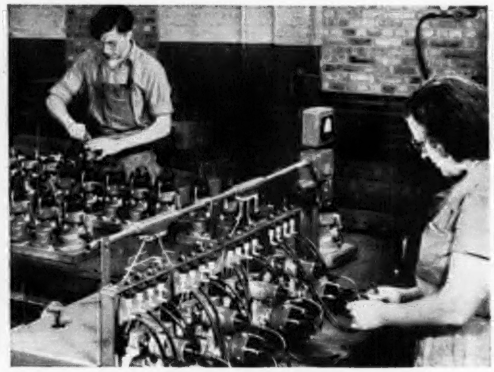

CLARK
Engineering

A report to you about men and machines that help maintain International Harvester leadership

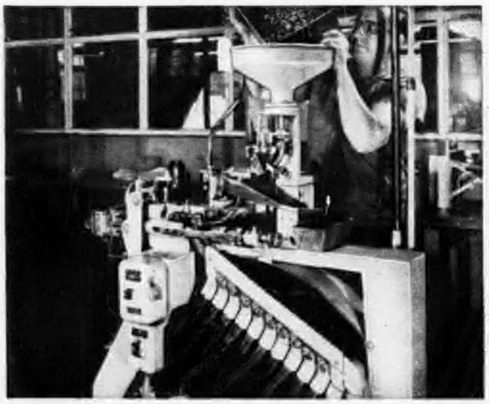
How modern science protects IH quality



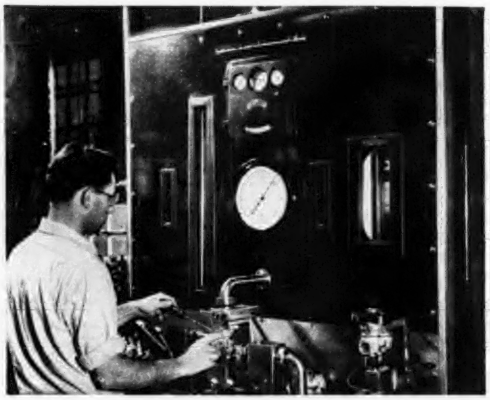
Blue light detective finds "bad" bolts that can't be spotted with the naked eye. Bolts are "dunked" in a fluorescent material and then magnetized. This causes the fluorescent material to gather in any tiny cracks and mark them with white lines under the blue light. All IH bolts used in connecting rods, main bearings, and flywheels are given the blue light test. This makes sure they have no unseen flaws to bring on costly breakdowns.



All IH distributors must show a "hot" spark before they are assembled on Farmall tractors. Here's an IH inspector giving four battery ignition distributors their final exam. They are operated at 1,725 rpm. The spark gap on the test plugs is set wide to simulate actual engine operating conditions. These distributors have already passed a spark advance test. Now, they are proving they have no shorts or grounds to keep them from operating efficiently.



Bearing rollers can't vary 1/10 the diameter of a human hair after they are sorted by this robot. An electrical brain gauges the diameter of each roller by the distance it enters a tapered slot—much as you would try on a ring—and opens the can for that size roller. This precision sorting keeps roller diameter similarity in IH bearings to .000125 of an inch. This perfect matching assures smooth operation and long life.



Flow test reveals appetite of IH carburetors. IH inspectors check carburetors for gas and air consumption in both idle and wide open position. The vacuum registered by the big dial simulates engine speed. The thermometer-like gauges, which record the amount of gas and air used at these speeds, enable IH inspectors to spot defective or improperly adjusted carburetors that might waste fuel. A Farmall Cub carburetor is shown under test.

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EDITORIAL

Dairy Labor and Construction Economy

LABOR scarcity, labor cost and building costs are becoming increasingly critical items to the dairy farmer. Some people believe that considerably more can be done to hold the line on these items than has been accepted in common practice to date.

In the October issue of *Hoard's Dairyman*, Frank N. G. Kranick, agricultural engineer (Life-Fellow and Past-President ASAE), challenges his colleagues to meet and solve the "Problem of high-cost farm structures which carry with them a perennial heavy labor cost."

He proposes further engineering attention to labor-saving livestock building layout, design, and management along lines previously recommended by Edwin L. Hansen and others. Some of these improvements are already at least partially proven in limited practice and awaiting broader application.

As a starting point for further discussion rather than as any ultimate in design, his article is accompanied by a proposed building layout for the prevailing small dairy farm. It provides for a pen-type barn with the usual feeding, loafing and milking areas and related features. More unique items suggested, with a special view to labor saving, are multiple upright silo-type bins adjacent to the feed area for storing ensilage, chopped hay, grain, and bedding; a fixed elevator arrangement for filling the bins; space for hogs and poultry at one end of the barn; and an adjacent machine shed and shop.

One or more new buildings or extensive remodeling is never a simple and easy solution to all the problems of the individual dairy farmer. Over the length and breadth of the country, however, new dairy construction and remodeling are continually in progress. To a larger extent than is true at present, this might be recognized as an opportunity for farmers to increase their margin between cost and selling price, without subsidy, increased controls, or increased cost to consumers.

We cannot be sure that dairy production costs have been reduced to a practical minimum until the cost of every detail, every item of related construction has been justified as a contribution to the whole operation. Every feature from foundation to roof should justify the investment, as a modifier of environment to improve the productivity and health of the animals, sanitation, the conditioning and preservation of feed, working conditions, work efficiency, or the service life of the structure. Each detail should likewise be justified in comparison with other materials and methods of construction which might be used to do the same job. More costly mistakes are apt to be made on details than in adapting building size to scale of operations. Labor-saving possibilities are one of the opportunities for economy most easily overlooked.

There is no longer any physical reason for using manual labor in handling feed, water, or milk, or in barn cleaning. On the economic side, the means of saving one dollar in labor may justify an investment of $5 to $20, depending on what is actually necessary to provide the improvement and on its probable service life. The relationship between annual labor saving and investment might well be used as a guiding principle in making minor improvements as well as in new construction and extensive remodeling.

Dairymen will continue to spend a lot of time with their herds. So far as we know there is little prospect of mechanization supplanting human judgment as to the condition of an animal, or taking over other management functions. Mr. Kranick proposes no pipe dream of push button dairying, but a realistic engineering approach to some physical factors which have an important bearing on a dairy farmer's production costs and capacity. He proposes that additional physical factors be engineered so that the dairy farmer may have more time and energy to apply to the management of biological and economic factors, so that the dairy farmer may be master rather than servant to his herd.

Research in Farm Safety

RESEARCH in farm safety matters has had to take second place to promotion of safe practices based on information which is already common knowledge.

This should not obscure the fact that definite contributions to farm safety can be made by research. A. J. Schwantes recently emphasized its place in the farm safety program, in addressing the farm section of the National Safety Congress. In brief he said, "That research in the field of farm safety is necessary appears self-evident from the standpoint of a continuing and developing program of resident teaching and extension. New subject matter must be developed in accordance with the changing needs. . . .

"To keep a farm and home safety program in progress and to keep it correlated with new farm developments and new practices, a program of research is important. Perhaps one of the most significant activities that could be engaged in on the local or county level is a survey of accidents that occur. It would appear that exact information with regard to the cause of accidents and details of the circumstances surrounding the accidents would be helpful in preventing future accidents. Such details are very often difficult to obtain and usually a local committee or group is in the best position to obtain the facts that are significant. A number of excellent reports of this nature have been made by local county groups.

"At the University of Minnesota a study is now under way to determine the exact cause of fatal tractor accidents. A survey blank has been developed for this purpose and the extension farm safety specialist has obtained information with regard to fifty-three such accidents. It is hoped that the information to become available from this study will point out the relative importance of various causes and also suggest remedies. This type of study might be extended over a wide range to include not only fatal accidents, but that large group which may or may not result in the injury of someone, but not in death. It might also include the operation of other farm machines and accidents due to livestock, falls and other causes.

"Certainly there is room for studies aimed at the improvement of mechanical equipment from the standpoint of the safety of the operator. In this connection the work of the farm equipment manufacturers through the Farm Safety Committee of the Farm Equipment Institute is to be commended. It is doubtless appropriate that certain studies in this category might well be engaged in by the research divisions of the land-grant agricultural colleges.

"Much can be done in studies of equipment, facilities, and even features of buildings themselves, in the home and about the farmstead toward reducing hazards of those who live and work there. It is possible that studies relating to human behavior under certain circumstances would yield helpful information in preventing accidents."

Even the best current safe practice recommendations might well be reviewed in farm safety research. Their limitations are suggested and measured by continuing high accident rates, in spite of excellent extension and resident teaching on accident prevention. Some better or additional approach to safety; more popular and easily observed safe practices; or engineering improvements to reduce the need for conscious attention to safety, are apparently needed in connection with those common types of farm accidents which resist reduction by educational methods alone.

Research in farm safety can be a low-cost substitute for some high-cost learning in the hard school of experience. It can provide more specific information on current major hazards to farmers and the physical means by which they might be reduced. It can anticipate and suggest means of avoiding hazards incidental to some of the new materials, designs, equipment and practices just beginning to come into common farm use. And it can consider the applicability to farming of the wealth of safety devices, principles, and practices continually being developed primarily for use in other industries.

Disking 17 acres per hour with Caterpillar Diesel Tractor and 36′ Towner Squadron Hitch Offset Disk Harrow equipped with Ingersoll Heat-Treated Discs.

AGRICULTURAL ENGINEERING

VOL. 32 NOVEMBER, 1951 No. 11

Twenty-five Years of Cotton Picker Development

By C. R. Hagen

STARTING a full century ago, as evidenced by patents recorded as early as the year 1850, many attempts have been made to harvest cotton by some means other than the slow, tedious hand-picking method.

Angus Campbell, a pattern maker of Chicago, recognized the need for a mechanical cotton picker during a visit to Texas in 1885. The idea of making a machine to do the picking occurred to him as he watched hundreds of men, women, and children, slowly dragging sacks through the fields as they picked cotton from the long rows of plants. His first machine appeared in the field in 1889.

Prior to the formation of the International Harvester Company in 1902, Angus Campbell in the experimental department of the Deering Harvester Company worked out many of the features of what was later known as the Price-Campbell cotton picker. Mr. Campbell continued to experiment and improve his machine under the direction and supervision of the Price-Campbell Cotton Picker Corp., from the date it was founded in 1910 until his death in 1922.

John F. Appleby, an associate of William Deering and famous as the inventor of the Appleby knotter for twine binders, also developed and built a number of spindle-type, cotton-picking machines during the early part of the present century.

Harvesting cotton was one of the few remaining phases of agriculture to be mechanized, and it was during the year 1922 that the International Harvester Co. revived their interest in the development of a cotton-harvesting machine. The first efforts were with a pneumatic-type picker, which at that time was thought to be the most desirable, least expensive and least complicated.

Three machines which operated on the principle of harvesting cotton by air suction were made in successive years. Hoses were applied by hand to the cotton bolls. Many small and aggravating difficulties were experienced with these machines, all of which could possibly have been overcome had it not been for the outstanding fact that a man burdened with the handling of the hose and nozzle could not work as fast as the man with bare hands and fingers. A final test of placing these machines in the same field with skilled hand pickers thoroughly convinced our management that, to be practical, the human element had to be entirely eliminated from the picking operation.

Actually 27½ years have passed since International Harvester began developing the spindle-type cotton picker, starting with the basic structure shown in the Price-Campbell patents which were purchased outright in January, 1924.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Houston, Tex., June, 1951, as a contribution of the Power and Machinery Division.

The author: C. R. HAGEN, chief engineer, advanced engineering dept., Memphis Works, International Harvester Co., Memphis, Tenn.

Fig. 1 Small experimental cotton picker in operation

In the picking operation revolving barbed spindles penetrate the plants and contact the lint in the open bolls; the barbs catch the cotton and extract it. The spacing of the spindles is such that an unopen boll fits between the spindles and remains on the plant. The entire plant compressed in the picking throat is penetrated by a regular spaced pattern of spindles, whose travel rearward is synchronized with the tractor travel forward.

Our first spindle-type picker was completed September 2, 1924, and was tested in the field in the vicinity of Dallas, Tex. This machine was of the one-row, self-propelled type, using four picking units, but rotary doffers were utilized in an effort to more positively remove the cotton from the spindles. The spindle spacing was changed to increase the clearance for green bolls. This spacing arrangement required timing of the picker-drum units so that the spindles did not strike one another, as they operated in the same plane. The long straight spindles in these early machines fitted in picking units directly across the row from each other, and the spindles were designed to break rather than bend if an obstacle was encountered on the row.

The construction of our second spindle-type picker was radically different from its predecessor, it being a trail-type machine with provision for being pulled by a tractor and equipped with only two picking drums arranged directly across the row from each other.

Power to operate the picking mechanism was derived from the rear wheels. The percentage of cotton picked with two picking drums was encouraging and another machine of the same type was built with improvements and modifications. The cam track was changed to allow the spindles to enter the plant without any noticeable gathering action and to leave in the same manner. The drivewheels were increased in width of face, with 4-in spade lugs to insure traction and allow the machine to operate in sandy and soft cotton fields.

This trail-type machine required one man to drive the tractor, one to steer the picker, and one to take care of the cotton bags. The tractor wheels brushed quite a lot of cotton from the stalks during a late season test at Wilson, Ark., and a makeshift frame was constructed of timbers attached to the frame of the tractor in such a manner that the picker would be offset sufficiently to pick the row on the outside of the rear tractor wheel. This arrangement eliminated the requirement for a man to steer the picker, and offset the picker so that it was unnecessary for the tractor to straddle a row that had not been picked. This proved to be an unwieldy arrangement and the succeeding trail-type pickers were not offset as far, the row picked being inside the right rear tractor wheel.

Power for driving the picking mechanism on the trail-type pickers made during 1926 through 1929

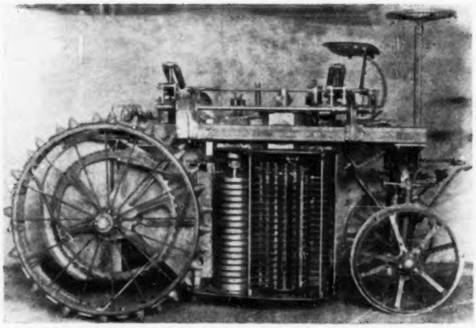


Fig. 2 Early experimental model (about 1925) of pull-type, ground-wheel-drive cotton picker

was supplied by the tractor power take-off. The trailing picking unit was developed and tested quite extensively in the Mississippi Delta. The machines did an acceptable job of picking but were difficult to keep on the row. Accurate and attentive driving was required for good results. Like all trail machines objection was made to the space required at ends of the field to turn around.

An ambitious program to build a limited number of these trail machines was carried on and parts for twenty such machines were practically completed when economic conditions changed abruptly with the financial crash in 1929. The following years of depression were definitely not favorable for the introduction, even in very limited quantity, of a machine that would replace labor. Experimenting, however, was continued and a picking unit designed to pick from one side of the row only, was built as an attachment to, and mounted on, a Farmall tractor.

The machines built from 1928 through 1930 were attempts to further simplify the picker. A machine built in 1930, and tested in the Phoenix, Ariz., area quite extensively, located the operator over the row and was equipped with a cleaner that functioned well in that arid section. This arrangement of mounting the picking unit on the tractor was also utilized in building several two-row attachment-type cotton pickers during 1931 and 1932.

During these years while progress was being made with the long, straight spindle picker that retained the cam controlled picker bars and the rotary doffer construction, investigation of the relative merits of other spindle-type pickers was checked into for comparison purposes. To accomplish this full-size machines were built and tested.

The doffing device developed by Hiram Berry of Greenville, Miss., was incorporated in a machine in 1928 and field tested in comparison with our rotary-type doffers.

A shuttle-type machine, also built in 1928, was experimented with. The desirable smaller number of spindles, arranged in two batteries and actuated by cranks, had all the familiar problems associated with picking and doffing, plus one of considerable vibration set up by movement of the two batteries of spindles in their travel cycles in and out of the row plants.

Results obtained with either of these machines were not as desirable as the results obtained with the spindle machine of our own design.

The picking spindles used in our machines up to 1930 were of the long, straight type. A great variety of spindles were developed and tested.

Because of the difficulty in removing the cotton from these long, straight spindles, shorter-length spindles with various degrees of taper were developed. The picker-bar construction used to this date was abandoned in favor of a radial-type picking drum incorporating the short tapered spindles.

The radial-type picking unit had no cam to position the spindles in the plant zone, and while this construction had merit in simplifying the picking mechanism, other features were found not so desirable and after many seasons of field testing the radial type was abandoned in favor of a return to the picker bar with tapered spindles utilizing the cam as in earlier model machines prior to 1930.

The early attempts to replace the slow, tedious hand-picking method met with many disappointments. Many years were required for development of the spindle-type machine because of the short picking season, and the inability to simulate conditions on a laboratory floor, thus requiring a full year before new ideas could be field tested.

Considerable opposition to mechanical picking was encountered in the field. Many cotton farmers were very skeptical, and sure that the cotton crop could not be mechanized. At the end of every harvest season we returned with a little more experience and a little more ridicule, for the average cotton grower believed firmly in the eternal supremacy of the Negro cotton picker. Distance was somewhat of a handicap with our engineering and shop facilities in the North and the test fields in the South and Southwest.

Cotton bolls on the same plant mature and open progressively, making the problem of mechanically picking cotton a complex and difficult one. A cotton-picking machine to be commercially successful must harvest a high percentage of mature cotton without injury to the unopen bolls and blooms, or to the foliage and the plant itself. The cotton must be gathered in a clean condition with a minimum amount of leaves, stems, hulls, weeds, etc., and the seed cotton must not be damaged so that the highest possible grade of ginned cotton may be obtained. Tags of cotton left in the bolls by the machine are particularly noticeable as the cotton shows up white against the dark background of the soil and plant foliage. Many observers were not convinced that the machine was doing a good job of picking until they participated in gleaning the plants and thereby realized what a small amount of cotton the tagging represented.

Actually it has been found that machine-picked cotton contains a higher percentage of longer and stronger fibers, because the spindles pick the pickable fluffy cotton, and have a

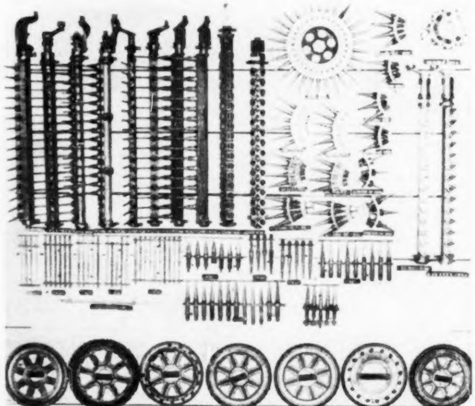


Fig. 3 This collection of representative samples of picker bars, picker spindles, doffers, and moisteners indicates progress over the years in the development of cotton picker "vital" parts

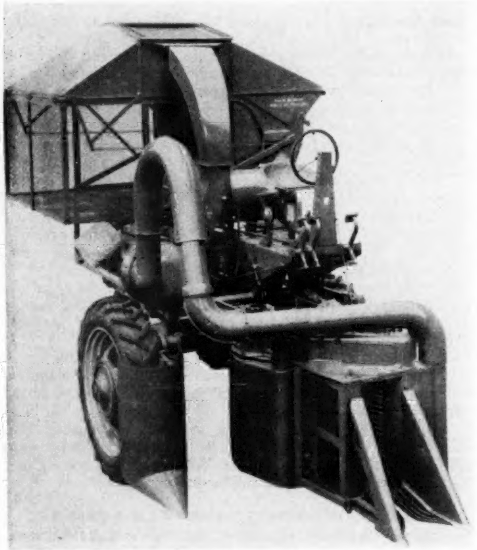


Fig. 4 This is the larger (M-12-H) of the three production models of spindle-type cotton picker currently being built by International Harvester Co.

tendency to leave the immature hard locks of cotton.

The picker spindles presented many problems. To pick a high percentage of cotton, spindles must be designed to be aggressive and have a high affinity for the cotton fibers, but it is equally important that the cotton release readily and the spindles be completely clean after doffing so that they continue to pick efficiently.

The long, straight spindles used in the early machines were difficult to doff. To assist the doffers in the removal of the cotton, the rotation of the spindles was stopped. Doffing troubles continued; rotation of the spindles was stopped and direction of spindle rotation was reversed. The time element was too short; a split second to stop rotation and start in opposite direction proved to be too severe on reverse racks and other actuating mechanism. The continuous rotating tapered spindle used in today's machine is an outgrowth born of the difficulties experienced with doffing the cotton from the long, straight-type spindles.

A single radial drum-type cotton picker equipped with the shorter tapered spindles and mounted as an attachment on an F-12 Farmall back in 1933, was an attempt to develop a machine for the small farmer.

To further improve the picking percentage a machine was built the following year with two reduced diameter radial drums arranged in tandem, both drums of tapered spindles picking the plants from the same side of the row.

An important step in this development took place in the early thirties in arranging two picking drum units in staggered fashion, one ahead of the other on opposite sides of the row.

Such an arrangement was first built and carried on a self-propelled machine especially designed to accommodate the staggered-drum arrangement. With this type of picking arrangement the plants are picked twice, once from each side of the row, each picking drum of spindles being entirely independent and operating in the plants without interference with the other.

Spring-mounted plant compressor sheets function to hold the plant within the picking zone, and also serve as a safety means for the mechanism in case a brickbat or other obstacle is encountered while the machine is driven over the row.

Conveying of the cotton from the doffers on all machines had been accomplished with belts. In 1934 several machines were built utilizing an air stream for conveying cotton, but air did not replace belt conveyors until further improvements just prior to 1940.

Mounting the staggered picking drums on a tractor necessitated carrying the drum box at the right rear and required shielding of the entire length of the tractor to insure a minimum of cotton being knocked off the plants before they had passed under the countershaft housing of the tractor and into the picker drum box.

Through the years 1936 to 1939 inclusive, many models of staggered picking units all mounted on F-20 Farmall tractors and variously equipped with cleaners, bagging devices, and baskets were built and field tested. In 1939 a change in the line of tractors eliminated the higher-clearance countershaft construction, and it was necessary to pass the plants under the lower tractor rear axle before they entered the picker unit.

An M tractor with extra-large-diameter drivewheels was built to provide the desired clearance for the plants.

As a result of field experience in the 1939 season, the idea of reversing the direction of travel of the tractor for cotton picker operation was conceived. This was accomplished in 1940 with a picker drum box mounted on an H tractor which was operated in reverse gear and which served the purpose for experimental tests. The advantages of this arrangement are readily apparent. The row of cotton plants pass through the picking throat of the machine first, and the cotton is picked before the plants contact any part of the tractor.

The operator is seated directly over the row for good driver vision. The large capacity basket is located out of the way behind the operator and over the top of the tractor hood. An interesting development over a period of several seasons was carried on in filling the basket completely and automatically with no attention from the operator.

Extremely wet seasons resulting in heavy rank plant growth were being experienced, and in order to relieve the crowding of much green foliage through the top portion of the picker throat, it was decided to increase the height of the picker drum box approximately 10 in. The first high-drum cotton picker was built in 1941, and at the same time a higher-clearance tractor was built to accommodate the high-drum picker and to further insure gentle handling of the plants with the tractor passing over the rows.

In the building of the high-clearance tractor, the regular tractor axle was utilized as a countershaft, and by adding gear housings we obtained full reversal of all forward speeds, which permits two picking speeds and also a choice of higher transport speeds. Ten machines were built and tested in 1941. All picking attachments were mounted on modified or high-clearance H tractors. The Model H tractor was selected as most desirable considering cost and weight.

In November, 1942, after these latest experimental cotton pickers had conclusively proved that they met all the requirements for the successful picking of cotton, the International Harvester Company made a public announcement that the machine was ready for production. The mechanical picker offered a favorable solution to the critical labor shortage in the cotton country as a result of the war. Many cotton cabins were empty. Some thirty machines built in the engineering department from 1941 through 1943 and 75 machines built by the manufacturing department in 1944 were equipped with a two-fan and separator-box cotton conveyor system. Experience with machines in late season field conditions indicated increased power was needed to operate in muddy fields and the high-drum picking attachment was therefore designed to mount on the M tractor. The greater power of this tractor is more desirable also for other farm operations in the Mississippi Delta and the irrigated Southwest where cotton pickers have been introduced in largest number.

During 1945 in the cause of further lowering the cost of the machine, as well as to simplify the operator's task, a simple one-fan cotton conveyor system was adopted and is in use on present production machines.

An effort to provide a picker for "short" cotton was made in 1942 through 1944. The picker unit consisted of two picker

drums, tandem arranged, picking the row of plants twice from the same side. Ten of these picking attachments were mounted on Model B Farmall tractors and have reportedly done a good job of picking when operated in plants of suitable height. The picker bars were fitted with only 10 spindles whereas the production high-drum machine has 20 spindles.

A machine which has been revived recently is the 14 high series which was experimented with for many years prior to the introduction of the 20 high series as the machine to sell to the trade. The one-row, high-drum machine was arrived at after many years of field testing, redesigning, experimenting and rebuilding. The machine in the 20 high-spindle height was selected as the introductory machine because it was best qualified to meet the great number of variables found in the cotton fields across our entire South.

Some progress has been made toward adapting the 14 high series cotton-picking attachment to our Model C Farmall tractor in an attempt to provide a lighter weight and lower cost machine.

Two-row machines have been experimented with for many years but preference was given to first producing a satisfactory one-row machine. In the early experimental days a two-row machine was apt to further delay progress when trouble was encountered, and many of the attachment-type machines, although designed to accommodate two picking units, went to the field fitted up for picking one row only for test purposes.

A two-row machine utilizing two of the 14-series cotton-picking units, incorporating the time-proven staggered picking drums, was built and tested in the Mississippi Delta and in California last season. It has a new feature in that alternate rows of the same planting are picked. Most large acreages of cotton are planted and cultivated with four-row equipment. With this picker, if rows 1 and 3 are picked first, rows 2 and 4 are picked on the return trip. This two-row machine is designed as an attachment to the M Farmall tractor. The picking units are interchangeable, not rights or lefts. Farmers may wish to purchase a one-row machine to which at a later date the second-row attachment may be added. This arrangement in addition to using standard production one-row picking units has the feature of accessibility to the working parts.

Good high-percentage picking depends primarily on the spindles with the doffers playing an important part in removing the cotton. Another important functioning part of the picking mechanism is the moistener unit. In green plants spindles foul up with a mixture of plant sap, dirt and cotton fibers. In the early days of the long, straight spindles, this building up of knots of lint on the spindles was a real obstacle to continuous operation and periodically this build-up of material had to be removed by hand, aided with pocket knives and liberal applications of water.

TEST DEVICES TO APPLY WATER TO PICKER SPINDLES

Many devices to apply water to the picker spindle surfaces were tested, but all failed to do a consistently complete job, until water from a distributing device was piped in equal amounts to each row of spindles. A film of water is applied by means of specially designed rubber wiper pads to the entire conical picking surface of every spindle in each of the twenty rows just before the spindles enter the picking zone.

A great many conditions have improved since our first mechanical cotton-picking machines embarked on their initial field tests. There has been a gradual improvement, particularly during the past ten years, in both plant and field conditions that have eased the job for the machine. After the picker was recognized as having "arrived", and the introductory machines had proven themselves to even the most skeptical, many agencies went to work on problems that have all helped to contribute in no small measure to the success of the cotton picker.

At first there was a tendency to attempt to harvest the crop too early, influenced somewhat by the hand picking. Some early season tests with experimental machines were made to insure time to make changes and return the machines to the field for results the same season.

Changes and improvements were made on many machines, extending out beyond the normal season, which was not always conducive to good results as plant stems became very brittle and cotton was dislodged from the plants by the slightest contact.

In the early season the plant foliage presents the most serious and difficult operating condition for mechanical pickers. Experience taught us that there is a right and a wrong time to start picking, depending on condition of plant foliage and percentage of open pickable cotton. "Live" green or "juicy" green leaves, army worms and so called "honey dew" caused by plant lice added to the early-day trials.

Today much of the insect life on modern cotton plantations is kept under control quite well with insecticides. Defoliation when successfully accomplished has definitely done much not only to denude the plant of leaves, but has prepared the plants for easier mechanical harvesting by doing away with a great deal of the green stickiness that was difficult to cope with. Defoliation permits the sun to reach the bolls and mature a greater percentage of bolls earlier, and the sample picked from successfully defoliated plants contain a comparatively small amount of leaf trash.

A poor or incomplete job of defoliation results in the leaves drying and lodging in the plants, subsequently being crumbled and ground up in small particles and mixed with the cotton during the picking process.

Improved varieties of cotton, methods of planting, soil management, tillage practice, insect control, and defoliation have all contributed to help harvest the crop mechanically, and improve the grade of machine-picked cotton.

COTTON PRODUCTION EXPANDS TO THE WEST

Cotton's westward expansion goes on at increased rate. Conditions existing in most of the arid sections of the West are more favorable to mechanical harvesting of cotton than they are in many of the humid sections of the East.

Improved drying, cleaning and ginning equipment is another very important factor which was recognized as a necessity in the early development days of the picker as well as the stripper. Because cotton has to be partially processed before the farmer can sell his crop, we interested ourselves very vitally in the proper handling, drying, cleaning, and ginning of machine-picked cotton.

The cleaning mechanism was an important part of many of the early cotton pickers and cotton strippers.

However, cleaners mounted on field machines, besides having the disadvantage of added weight, also were limited in capacity. A cotton picker equipped with a cleaner would usually be delayed in starting on a damp morning and also be restricted to operation in fields of lighter yields because of cleaning capacity.

Stationary cleaners in the field required additional handling of the crop.

A large experimental drier and cleaner for machine-picked cotton was erected alongside the cotton gin building on the Hopson Plantation near Clarksdale, Miss., during 1937. This cleaner was designed to handle the cotton gently a great number of times and many thousands of bales of machine-picked cotton were passed through this cleaner before ginning, with beneficial results.

A compact arrangement of three cleaners and a drying unit was hauled with our test caravan for several years to prove to ourselves and others that it was not impossible to clean machine-picked cotton and obtain improved grades. Considerable time was spent cooperating with the cotton gin and cleaning machinery manufacturers to acquaint them with conditions of machine-picked cotton.

An experimental gin and cleaner installation was built on the Ohlendorf Plantation near Osceola, Ark., to prove more conclusively how the grade of machine-picked cotton could be improved with further development of cleaners and driers.

After many years of experience in cleaning freshly harvested machine-picked cotton, the conclusion was reached that to be thoroughly and successfully accomplished, mechanically-picked cotton should be dried and then cleaned at the gin, where it can be done properly at a slower rate with equipment less restricted in size and capacity.

(Continued on page 599)

Land Preparation for Irrigation and Drainage

By Ivan D. Wood
FELLOW ASAE

APPLICATION of water from streams and rivers to the land has been a practice followed by farmers in almost every country for unknown ages. The remnants of ancient irrigation systems can be found along with the remains of almost every past civilization.

In the United States irrigation was extensively practiced by the aboriginal tribes of our own Southwest. Near where the city of Phoenix, Ariz., now stands some ancient race irrigated lands which supported 20 large communities. More than 150 miles of main canals have been traced. It is believed that the first extensive irrigation by white men on this continent was done by the Mormon settlers in the Salt Lake Valley more than 100 years ago. The waters of what is now City Creek were diverted upon small areas of land which was later planted to potatoes.

In building these early irrigation systems little was done to improve the land surface in order that water application might be made easier and more effective. Usually the irrigation system consisting of ditches and laterals was designed to fit the existing topography. Small laterals were carried out upon the ridges and the water allowed to run down the steepest available slopes.

With some of the earliest systems little other than wild flooding was practiced. A portion of the stream was diverted to the high side of the field with a plow furrow or small ditch, and banks were cut allowing the water to flow unevenly over the surface. In these early days very little attention was given to the water-holding capacities of the soil, to the erosion of the surface which resulted from poor application practices, and very little was known about labor-saving devices and structures.

Irrigation Comes to East. Early irrigation developments were confined, for the most part, to the west where rainfall is insufficient for growing other than grain and hay and where frequent droughts sometimes cause complete crop failures. In late years it has been found that irrigation is profitable even in those areas of rather abundant rainfall. Certain crops require an adequate supply of moisture from the beginning of their growing season to the end. Even a drought of short duration may greatly depreciate both the quality and the yield. Thus we find the trend of irrigation to the eastward. Often a combination of drainage and irrigation is necessary in the same field. The rainfall of spring and early summer may cause wet conditions of fields which hamper crop growth and seriously retard farming operations.

The latter condition is particularly true in those areas where the land has little natural slope and where the microtopography shows many potholes which in some cases may occupy as much as 30 to 40 per cent of the entire field surface.

Up to the present time irrigation in the eastern states has been accomplished mainly through the use of sprinkler systems. Until the 1950 census is available, no very accurate estimate can be made of the number of acres so irrigated. It is known, however, that the increase has been phenomenal even in such states as Florida, Iowa, Illinois and Indiana. Had the sources of supply been more abundant the increase would have been much greater.

Land-Preparation Practices in the West. Very little land preparation was done in the beginning of irrigation in the West. The topography of the field was accepted as it existed in its natural state and the irrigation system was designed to fit it. This type of planning resulted in many small fields with a variety of row directions, ditches which followed ridges and irrigation water being diverted down steep slopes. The ultimate result was serious erosion problems and the use of an undue amount of labor in water distribution.

The present tendency in western land preparation is to modify the land surface to fit a predetermined irrigation system wherever the depth of soil will permit. The various modifications now being employed consist in producing uniform slopes, reducing existing slopes, reducing to a minimum the number of fields and consequent row directions, and planning for a reduction in labor when water is applied to the land.

I should say that the tendency in the west at present so far as land preparation is concerned is toward such modification of the land surface as will produce the highest application efficiency with a minimum of work, and this goal has been accomplished through the research and operation of several agencies and has been made necessary for economic reasons. In many cases the irrigation farmer has no hired help. He must not only handle the irrigation water but all his farming operations in addition. This has called for an irrigation system which is a far cry from that used by the early pioneers.

Irrigation Problems in the East. As has already been stated, areas of high rainfall are subject to periods of drought when the yield and quality of certain crops may be seriously damaged. The same areas are subject to periods of heavy rainfall in the spring and early summer. Under certain topographic and soils conditions serious crop damage may result.

While it has long been thought that the sprinkler system is the only successful one to use in areas of high rainfall, the problem may be solved by modifying the land surface to produce good drainage as well as permitting gravity irrigation. The author contends that this is not so. It is probable that a likely explanation of this thinking may be found in the fact that western irrigation techniques and know-how have not been well understood in the East. From experiences in several states it has been shown that the character of the land surface can be modified to produce conditions suitable to gravity irrigation and also to good surface drainage.

Along the Missouri River in western Iowa some notable results have been accomplished along this line. In this particular area it is possible to obtain a good underground water supply from gravel sheets lying rather close to the surface. Irrigation wells are relatively cheap and easy to construct. In this instance, it would have been possible to have pumped directly from the well into an irrigation sprinkler line, but it would also have been necessary to modify the land surface to produce good surface drainage to dispose of spring and early summer rainfall. It seemed logical, therefore, to attempt to produce a land surface which would permit irrigation water to be distributed by gravity in furrows and at the same time allow these furrows to remove spring and early summer rainfall.

The combination irrigation and surface drainage system may be designed in a variety of ways. In areas where there is little or no natural slope, it is necessary to so modify the land surface that proper grades will be provided to remove excess water from rains. Fig. 1 is a cross section of a 40-acre field showing one method of grading which has been successfully used. Wide drains, made with heavy earth-moving machinery, are placed at either side and through the center. These drains are easily crossed with farm machines and should connect

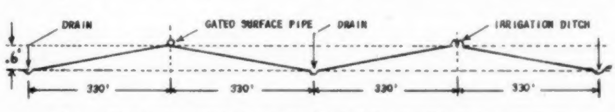


Fig. 1 Cross section through a 40-acre field graded for drainage and irrigation

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1950, as a contribution of the Soil and Water Division.

The author: IVAN D. WOOD, irrigation engineer, Soil Conservation Service, U.S. Department of Agriculture, Denver, Colo.

with main drainage ditches or laterals thereto. The land surface is graded to allow from 0.4 to 0.6-ft fall from a ridge midway between drains. The 40-acre field now contains two ridges and three drains; however, each side drain serves a strip 330 ft wide in the adjoining field. Good surface drainage is provided since the pot-holes are filled and each furrow which crosses the drain at right angles serves as a carrier of excess water.

Fig. 2 Head control for row crops

Fig. 2 represents two means of conducting irrigation water along the ridge and distributing it to each furrow. An irrigation ditch on the ridge provided with siphon tubes, one to each row, requires only a small initial outlay of cash. Gated surface pipe (described later) is more expensive but also much more convenient to use.

Proposed Designs for Irrigation and Drainage. The first step in the design of a combined irrigation and drainage system is the evaluation of the farm unit or fields involved. The making of a conservation map includes an examination of the soil to a considerable depth, an extremely accurate topographic map, an examination of the water supply possibilities, facilities for disposing of excess flood water, and other pertinent data.

Some land surfaces involved are so flat that the making of a topographic map is practically impossible. It has been found advantageous to stake the field in rectangular coordinates, the stake lines being placed either 50 or 100 ft apart depending on local conditions. Often these same stakes can be used in grading operations.

An extremely accurate soil map is necessary to determine where land leveling can be safely done, and the position of the water table should also be located if it is liable to come within the crop root zone at any time during the growing season.

In cases where there is no natural fall to be taken into consideration, the field may be graded into a series of sloping planes leading the water toward well-defined drainage courses as explained in previous diagrams. The drainage courses or ditches should be wide enough to cross with any type of machinery. The spacing of these drainage courses across the field will depend on natural slope available and other conditions. It has been found convenient to space them 660 ft apart. The ridge between carries the irrigation ditch or gated surface pipe.

The sloping planes are usually given a grade ranging from 0.1 to 0.2 ft per hundred feet. This fall in the furrow will generally remove flood water soon enough to prevent damage and will carry a non-erosive furrow stream when irrigating.

Fig. 3 is one typical design for a 40-acre unit where the land surface is flat. Three drains and two irrigation ditches service the tract. The drains are given some grade from the center of the field toward either end. The same is true of the irrigation ditches. A pumped well at A furnishes the supply which should not be less than 1 cfs or 450 gpm. At this rate of delivery a 2-in application of water can be made over the 40 acres in 80 hr or ten 8-hr days.

The cost of the combined drainage irrigation system will depend upon conditions to be met and equipment used. If the land has sufficient natural fall, grading operations may be confined to smoothing the surface, the main cost factors being the wide field drains, the pumping plant, irrigation ditches or gated surface pipe.

The cost of a system as shown in Fig. 3 would probably be about as follows, if the natural land surface were flat and the finished planes were given a fall of 0.2 ft in 100 ft and aluminum gated surface pipe were used:

10,000 cu yd of grading at 15c	$1,500
Three drains (two chargeable to this unit)	200
600 ft of 12-in gated surface pipe	1,000
	$2,700

Cost per acre, $67.50

Using irrigation ditches and siphon tubes instead of gated pipe, the cost would be as follows:

10,000 cu yd of grading at 15c	$1,500
Two drains	200
Irrigation ditches	100
Siphon tubes and check dams	150
	$1,950

Cost per acre, $48.75

The expense of providing a dependable source of supply is difficult to estimate. In some cases the water of a stream could be diverted at small cost. In other cases an inexpensive, horizontal centrifugal pump could be used for lifting the supply from a stream or lake at small expense. Where it is necessary to drill an irrigation well, install casing and provide a power plant, the expense may often run in excess of $2,000, or $50 per acre for the 40-acre unit. Some source of water supply, however, is necessary no matter what type of irrigation is installed, be it gravity or sprinkler. Some actual installations of combined irrigation and drainage systems made by large canning companies in Iowa have cost approximately $47 per acre. In this case some very inexpensive irrigation wells and pumping equipment were used. Experiences during the spring of 1950 showed the system to have worked perfectly. On land which was not so treated in the immediate vicinity crops were badly damaged. One operator reports that despite the extremely heavy rainfall he has an excellent crop of wheat on land which under ordinary circumstances would have netted nothing.

Maintenance of Land Surface. One of the most difficult jobs in gravity irrigation is maintenance of the land surface. After a careful and expensive job of land leveling has been done little will be gained if the surface is disturbed by indiscriminate plowing or by other operations.

The two-way plow is extensively used on irrigated lands since it is partially successful in maintaining a smooth surface. This implement has two sets of shares and while one is in operation the other is lifted clear of the ground. It is not necessary to plow in lands since the operator can turn, lower the alternate set of shares, and go back filling the furrow which has just been plowed. More recently many western irrigators favor tillage machinery using sweeps which simply cut through the soil, raise it slightly and drop it back in the original location.

Various types of land-smoothing machinery are available. Most of these machines are long and are provided with a cen-

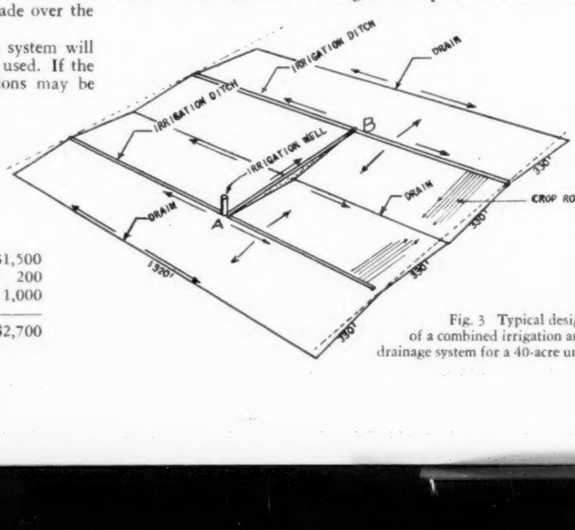


Fig. 3 Typical design of a combined irrigation and drainage system for a 40-acre unit

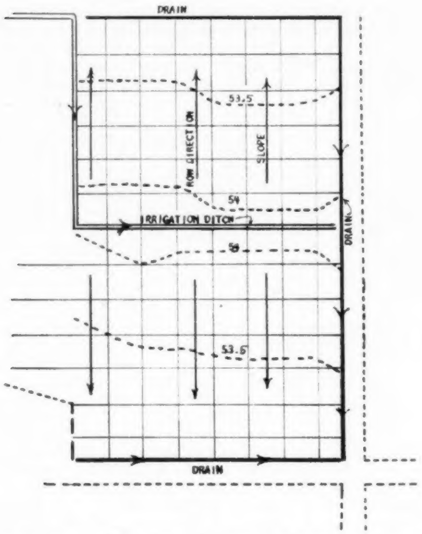


Fig. 4 This shows a portion of a field in Fremont County, Iowa, designed and constructed for irrigation and drainage

tral blade. Their operation is much like a carpenter's plane. They cut the high spots and fill in the low ones. Practically all of these machines are now hydraulically operated and do not require a great deal of experience on the part of the tractor driver. Where gravity irrigation is to be practiced some type of land-smoothing equipment should be operated over the land surface at least once each season. These machines range from 6 to 8 ft in width and the smoothing operation is not particularly expensive. These same machines could be used for maintaining the wide drains.

Head Control for Irrigation Water. When irrigation water is brought to the land by gravity methods control of the flow in each furrow is extremely important. Excessive flows are wasteful of water due to tail water loss at the lower end of the furrow and are liable to cause serious erosion.

Modern methods of head control consist in the use of siphon tubes of various sizes and kinds. For a length of run of 330 ft as indicated in this paper, it is probable that a ¾ or 1-in siphon tube for each row will be sufficient for most soils. It is common practice to use two siphon tubes in each row until the water has reached the end of the furrow and then to reduce the flow by removing one tube or substituting a smaller one.

More recently gated surface pipe has come into extensive use. This pipe is made in sizes from 3 to 12 in in diameter, in lengths of 10 ft, and of either steel or aluminum. Along the sides of the pipe are adjustable gates spaced to correspond to each furrow. The gates may be opened or closed at will

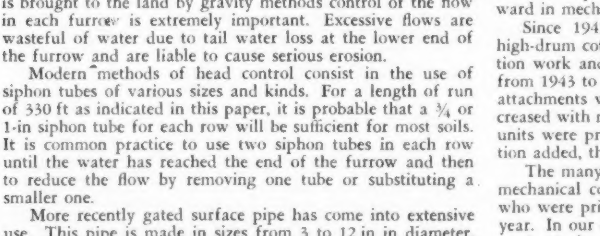


Fig. 5 Cross section north and south of the near east side of the field shown in Fig. 4

depending on the flow required. When pumping from a well or stream, water is usually delivered into a vertical standpipe and then into the gated pipe.

Preparedness Is the Watchword. In areas where soil and topographic conditions are such as to produce a drainage problem in the spring, the operator must certainly be prepared for immediate removal of excess water from the land surface. This can best be done by modification of the land surface to produce the necessary drainage and removing the excess water quickly before crops are damaged.

Often in these very same areas irrigation water is needed during certain hot, dry periods of the summer. The same modification of the land surface which will produce drainage will also permit of gravity irrigation. The operator should, however, be prepared to put the system into operation immediately at any time. By the use of the gated surface pipe it is possible to have water running in the furrows in a matter of a few hours. Stringing the light portable pipe through the fields and adjusting the gates is a relatively simple matter and one which does not require a great deal of man labor.

A knowledge of soil moisture conditions is essential and this can only be obtained by soil borings and sampling for moisture content. It is essential that the system be started in operation before all the readily available moisture has been exhausted in order to prevent excessive damage to the crop. The application of irrigation water requires time when small heads of water are used. Attention is called to the fact that using 450 gpm approximately 80 hr are required to apply a 2-in irrigation to a 40-acre field.

Cotton Picker Development

(Continued from page 596)

Cleaning of mechanically-picked cotton was definitely the ginners job, and perfecting and manufacture of cleaning equipment was the responsibility of the cotton gin and cleaning machinery manufacturers. As proof of a job well done many existing cotton gins have been improved with the latest cleaning equipment, and a considerable number of modern cotton-gin installations have been erected wherever mechanical pickers are operated in appreciable number.

The 18 years of cotton-picker development from 1924 to 1942 included a great variety of work, all of it necessary to final accomplishment of a practical machine, and a step forward in mechanizing the cotton crop.

Since 1942 continued improvement of the introductory high-drum cotton picker has proceeded along with cost reduction work and changes to facilitate manufacture. Production from 1943 to 1948 was very limited. Only 325 cotton-picking attachments were built and sold. In 1948 production was increased with new factory facilities provided, and 3,175 picking units were produced prior to 1951. With this year's production added, the total should be approximately 5,000 machines.

The many years of effort put into the development of the mechanical cotton picker seems justified in the eyes of those who were privileged to participate in the progress year after year. In our country today it is good to reflect that the 5,000 mechanical cotton pickers in the field represent the release of an army of over 100,000 men for more important work.

Engineering Employment

HIGH lights of the current employment situation and outlook in the profession are, briefly, as follows: A serious shortage of engineers has developed since mid-1950, owing primarily to the increased demand for personnel generated by the defense program. Opportunities both for new graduates and for experienced men will be excellent in the near future. Over the long run, the profession will probably continue to expand substantially, under conditions either of peacetime full employment or of continuing mobilization.—From August, 1951, supplement to Bulletin No. 968, "Employment Outlook for Engineers," U.S. Department of Labor.

"Effect of Present Installation Practices on Draintile Loading"

TO THE EDITOR:

IN THE above-titled paper in AGRICULTURAL ENGINEERING for July, 1951, Schlick, Frevert, and Schilfgaarde presented three nomographs for the determination of the design loads on underground conduits. Due to the great increase in the use of tile-trenching machines, it is extremely important that consideration should be given to the width, as well as depth of trench in which tile was laid. In general, trenches average considerably wider than when hand-digging was almost universally practiced.

The paper states, under the subtitle "Miller's nomograph," that "... With the change in installation practices, however, the loading conditions have been changed so that this formula does not always apply. Consequently the loads as determined by means of Miller's nomograph are not always those which one would obtain from the Marston theory ..." This statement is correct to a certain extent. It seems, though, that more should be said as to the merits and limitations of Miller's nomograph.

The accompanying table, which has been used for the past several years in Minnesota*, shows the maximum load on various sizes of tile under different depths of cover. It should be noted that, for a particular size tile, there is a minimum trench width which gives the maximum load under a certain depth of cover over the tile. Beyond this minimum width, a further increase in width does not increase the load. This fact is also indicated in Fig. 3 of the paper mentioned. For a certain size tile, if the ditch width is less than that shown in the accompanying table, Miller's nomograph is fully applicable. When the width increases beyond the minimum value indicated, Miller's nomograph should be replaced with the figures in the table.

In fact, the nomographs given by Schlick, Frevert, and Schilfgaarde can be considered as the combination of Miller's nomograph and the table. As can be seen from the example given in the paper, where the first W_c is 2470 lb per lin ft for a B_c of 1.0 ft, this is very close to the figure 2450 lb per lin ft calculated from Miller's table, while the second W_c based on $B_d = 1.5$ ft gives 1130 lb per lin ft which is to be used as the design load. This value is given as 1150 by Miller's nomograph. In this case, of course, the width of ditch is well within the minimum value shown in Miller's table.

To take another example, suppose a 6-in tile is installed with a 4-ft cover in a ditch 24 in wide in thoroughly wet clay. This ditch width is purposely selected greater than the minimum width given by the table. From Miller's nomograph, the load W_c would be 1150 lb per lin ft, while the table gives 780 lb per lin ft for a cover of 4 ft. Thus the maximum load of 780 lb per lin ft should be used as the design load. If we use the nomograph given by the authors (Fig. 4) there are two readings, $W_c = 1130$ lb per lin ft and $W_c =$ below 800 lb per lin ft, presumbly equal to about 780 lb per lin ft. The lower reading, according to authors, should be used for design load.

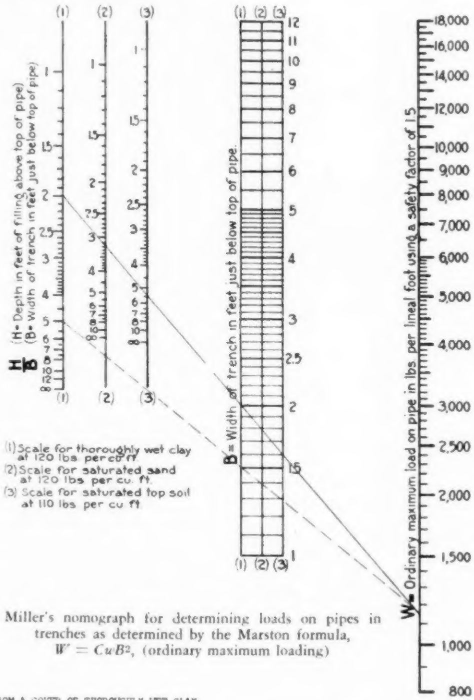
In general, for smaller size tile, the application of Miller's nomograph might give results which were too high because the standard ditch made by the trenching machine is more likely to be wider than the minimum width shown in the table. As for the large size tile, Miller's nomograph usually gives the proper load on the safe side. It follows that using either the authors' nomographs or Miller's nomograph, supplemented with the table shown, gives essentially the same results.

The paper by Schlick, Frevert, Schilfgaarde is a valuable contribution to the subject of loads on pipes in ditches as determined by the Marston formula. The paper not only emphasizes the importance of careful consideration of trench width, as well as depth, when calculating the loads, but also in the meantime clarifies some of the misconceptions regarding the influence on loads of extremely wide ditches.

Graduate student
Division of agricultural engineering
University of Minnesota

ROBERT CHEN

*Miller, Dalton G.: Unpublished data.



Miller's nomograph for determining loads on pipes in trenches as determined by the Marston formula, $W = CwB^2$, (ordinary maximum loading)

MAXIMUM LOADS ON TILE WHICH RESULT FROM A COVER OF THOROUGHLY WET CLAY

Depth of cover over tile, ft	Inside diameter of tile																					
	4-in		5-in		6-in		8-in		10-in		12-in		15-in		18-in		24-in		30-in		36-in	
	Trench width, in	Load, lb per lin ft	Trench width, in	Load lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft	Trench width, in	Load, lb per lin ft
2	12	270	13	320	15	360	18	450	21	530	23	620	26	690	29	770	36	1000	42	1170	50	1490
3	13	430	15	510	17	580	20	740	24	880	28	1040	31	1240	34	1340	41	1690	47	1970	54	2200
4	14	560	17	700	18	780	22	1010	26	1220	29	1440	34	1690	39	1930	46	2380	53	2770	59	3170
5	15	710	18	870	20	1020	24	1300	27	1570	31	1850	36	2270	41	2600	50	3240	56	3650	63	4170
6	16	990	19	1060	21	1200	25	1610	29	1960	33	2320	38	2730	44	3170	53	4060	63	4860	67	5250
8	18	1200	21	1460	23	1620	28	2200	32	2710	36	3130	42	3690	47	4390	58	5710	68	6760	76	7690
10	20	1460	22	1830	25	2090	29	2650	34	3360	38	3930	44	4760	50	5670	62	7240	73	8790	82	10120
12	21	1800	24	2160	26	2480	31	3280	36	3950	41	4860	47	5920	53	6890	65	8850	77	11020	87	12710
14	23	2090	25	2530	28	2910	33	3870	38	4720	43	5580	49	6800	57	8300	69	10680	80	12980	91	15140
16	24	2390	27	2930	29	3330	34	4310	40	5410	45	6490	51	7750	59	9430	71	12220	83	14900	95	17640
18	25	2700	28	3280	31	3790	36	4950	42	6140	47	7420	53	8910	61	10600	73	14000	86	16910	97	19860
20	27	3060	30	3660	32	4210	37	5390	43	6230	49	8370	55	9780	63	11810	76	15550	89	19130	101	22500

NOTE 1: The trench widths shown in the above table are minimum widths for maximum loads. Greater widths are without significance.

NOTE 2: Loads are calculated by the Marston formula, $W = CwB^2$, in which C = coefficient based on type of fill material and H/B, w = 120 lb per cu ft for thoroughly wet clay (130 lb per cu ft recommended for extreme conditions), and B = width of trench at top of tile. A factor of safety of 1.5 is included in the values indicated.

Automatic Feed Grinding and Handling

By M. W. Forth, R. W. Mowery and L. S. Foote
ASSOC. MEMBER ASAE MEMBER ASAE

DEVELOPMENT of a completely automatic, electric feed-processing system that can be installed in corn cribs or feed-storage centers so that ear corn, small grain, and supplement can be removed from storage, fed into the grinder, and the finished product conveyed to feed wagon, self-feeder, or prefeeding storage, was the objective of the research project reported in this paper. Such a system enables the farmer to take advantage of electricity as an economical source of power, greatly reduces the labor of feed handling, and gives the operator the opportunity to do other chores while the feed is being processed.

The problem was divided into three basic segments, namely (1) the adaptation of small (5 - 15-hp) grinders to automatic feeding of ear corn and small grains, (2) design of mechanisms for conveying, feeding, blending, and dust control, and (3) the application of automatic controls for regulating the rate of feeding and providing overload, underload, and shutoff protection.

After preliminary test work on the necessary component parts in the laboratory, three farm installations were made. The first installation (Fig. 1) at the Russell McAllister farm, DeKalb County, has been used during the past two seasons to grind more than 3,500 bu of ear corn. A second cooperator, Stanley Wood, Champaign County, Ill., has ground 2,000 bu of ear corn. On this farm, tests were made on five mills and three general types of feeding conveyors between crib discharge and hammer mill. The third test model was a complete feed-processing unit on the Robert Lynch farm, Marshall County, Ill. On this farm, 2,500 bu of ear corn and 3,500 bu of small grain and protein have been preblended and ground for feeder cattle and hogs.

Service recorders, watthour meters, and scales or weighing devices were used to obtain data on dependability of operation, power consumption, and capacity. Detailed electrical load studies were made with continuous recording equipment to record voltage, current, and power requirements during operation. Because of noticeable differences in hammer mill and 5-hp motor performances on the test farms, comparative studies were made at the laboratory where voltage and feeding conditions could be duplicated for each test, and the reasons for the differences in capacity and energy consumption determined.

The hammer mills used in these tests were 5- to 15-hp size; two were hatchet-type mills with the blower integral with the hammer rotor, two had swinging-type hammers, and one had fixed-type hammers. (The latter three are referred to hereafter as conventional-type mills.) The feed chute or "hopper" of each mill was remodeled so that ear corn would slide down the chute into the throat of the mill. The throat section of each conventional type mill was enlarged to reduce the tendency to clog with husks and short pieces of stalks. This was not necessary on the hatchet-type mills because the chopping action agitated the feed in the chute or hopper.

When the hopper and throat sections of the conventional mills were modified, it became necessary to develop a method of controlling the splash back from the hammers. This was done by providing a hood to cover the discharge end of the feed conveyor.

Another problem evident in all three conventional-type mills was screen blockage and fan-intake plugging when excess shelled corn or small grain was mixed with ear corn. In such mills, having the screen at the bottom, the small grain dropped down through the coarse screen faster than the fan could remove it, yet no overload condition occurred in the mill in time to stop the conveyors and allow the mill to clear.

Limited experiments were made with a conventional hammer mill turned upside down and fed with an auger. This eliminated the problem of hopper and throat stoppage since the ears and small grain were forced directly into the hammers. It also simplified the control of splash back, and stopped screen blockage when small grain and ear corn were ground with a coarse screen. In tests involving the grinding of more than 500 bu of ear corn, no plugging of any sort occurred and capacity compared favorably with the conventional mills. It was also found that the mill could be stopped while operating under a severe overload condition, and then be restarted without manually clearing the grinding chamber since all the material in the mill would fall out of the hammers. This was an advantage when the grinder was shut off by time controls or by other automatic devices. The size of the screen was increased in order to maintain the same fineness modulus as when the mill was in a normal position.

Both hatchet-type mills delivered an excessive amount of air and created a severe dust problem which required special control methods. Also, because of the power used to create this higher air delivery, less power was available for grinding. The result was a lower capacity and higher energy requirement. It should be noted, however, that if this greater air delivery were utilized in conveying feed to point of use or storage, then the over-all efficiency might be comparable with other mills.

Crib Conveyors. Each of the farm installations presented slightly different crib arrangements and grinding setups. The most generally satisfactory installation was one in which the crib conveyor was 8 ft long (equal to the width of the crib) and where a portion of the crib was partitioned off to provide

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This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1950, as a contribution of the Rural Electric Division.

The authors: M. W. FORTH and R. W. MOWERY, assistants in agricultural engineering research, University of Illinois, Urbana, and L. S. FOOTE, agent, Farm Electrification Division, U.S. Department of Agriculture (Agricultural Engineering Bldg., University of Illinois, Urbana).

AUTHORS' NOTE: In 1948 agricultural engineers of the Public Service Co. of Northern Illinois developed a demonstration model of an automatic ear corn grinder, fed by a conveyor and driven by a 5-hp motor. The conveyor-drive motor was turned off and on by a solenoid-type overload relay in the motor circuit. In 1949 a project for developing and farm testing automatic feed-grinding units was established by the Illinois Agricultural Experiment Station with joint sponsorship by the Public Service Co. of Northern Illinois, Illinois Northern Utilities Co., and Western United Gas & Electric Co. The study was expanded later to include cooperation with the U.S. Department of Agriculture, Division of Farm Electrification.

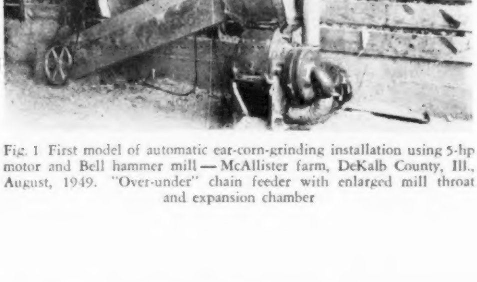


Fig. 1 First model of automatic ear-corn-grinding installation using 5-hp motor and Bell hammer mill — McAllister farm, DeKalb County, Ill., August, 1949. "Over-under" chain feeder with enlarged mill throat and expansion chamber

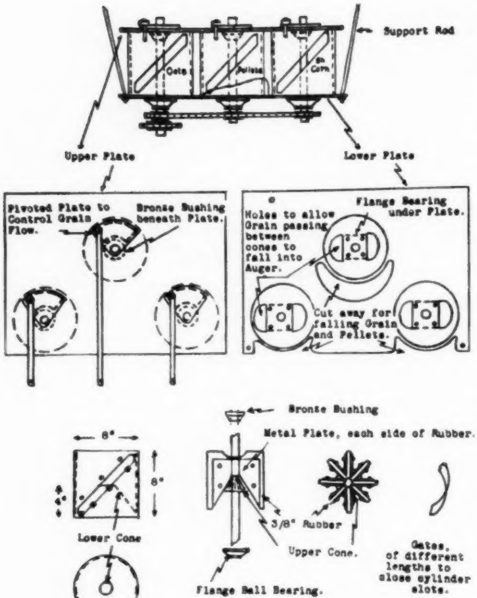


Fig. 2 Details of the blender used at the Lynch farm

a 500 to 1,000-bu "grinding bin." The grinder was then located in the crib driveway where small grain was delivered by gravity from overhead bins. Ear corn from various parts of the crib was moved by a sheller drag and conveyed to the grinding bin with the elevator ordinarily used to fill the cribs. A 2 x 12-in plank cover, the length of the conveyor, may be placed over the drag chain when the crib is being filled to prevent sticking of the chain in the grinding bin.

Several types of crib conveyors for removing the grain from storage were considered for installation in the bottom of the corn crib or grinding bin. The one used in these tests was selected because it was simple, low in cost, and operated satisfactorily in laboratory tests. The conveyor was of the surface type with the driver and idler shafts vertical, which permitted laying it flat on the crib floor. The idle side of the chain returned under one of the slanting hopper sides. No. 62 steel chain was used with flights cut from 1/4-in bar stock, 3 in high and 2 in wide and welded to C-1 flight links, with the long axis in the vertical position. The design features found to give best results were (1) sloping hopper sides at least 2 ft high on each side of the chain, set at an angle between 35 and 45 deg from the horizontal, (2) flight spacing between 7 and 10 in, (3) the flights high enough to agitate and move ears of corn, and (4) the bottom of the trough made approximately the width of an ear of corn (2½ in) so that the ears would be brought out endwise and singly.

A leveling gate made of either wood or sharp-edged steel plate, slotted for height adjustment, and fastened to the crib wall was used at the point where the crib conveyor came out of the crib. This leveling gate was set approximately 2 in above the top of the flights, although spacing was varied somewhat to adjust to the best operation. Husks and stalks bind under the gate if set too low. The conveyors were driven at a rate of 8 to 15 fpm by 1/3 to 1/2-hp motors. A series-type motor (3/4-in portable drill) was used on one test farm.

No serious problems of bridging were found in cribs where the corn was clean; however, at the Lynch farm, corn with excessive husk and stalk particles required the use of an agitator. An attempt to solve the problem of bridging with a moving apron was not satisfactory.

An agitator*, constructed from a piece of steel pipe 7 ft in length and 3 in in diameter with two bars of 1/4 x 1 in flat stock welded edgewise on opposite sides of the pipe, was mounted parallel to the movement of the ear corn conveyor and 8½ in above the flights. It was rotated at 2 rpm whenever bridging occurred in the ear corn bin.

Mill-Feeding Conveyors. Preliminary laboratory studies revealed that if the crib conveyor discharged directly into the mill hopper, the mill was easily overloaded and plugged because the ears of corn came from the crib two or three at a time. This difficulty was overcome by placing a feeding conveyor between the crib discharge and grinder and elevating the corn to the grinder hopper.

Three types of feeder conveyors between crib discharge and mill were tried: (1) over-under, with chain and flights and with rubber belts with special surfaces, (2) surface type, with chain and flights, and (3) augers.

The first two of these, using both over and under and surface arrangements, caused piling up of cobs and grain at the foot of the conveyor. The auger feeder was the most satisfactory. There was no return motion to catch the "splash back" and spill it on the floor. The auger was fitted in a U-shaped trough with sides at least 4 in higher than the auger. Both 7- and 10-in augers operated satisfactorily; a 6-in auger was found to be too small.

The augers turned between 50 and 100 rpm, and the chain conveyors were run at 80 fpm. Feeder speeds slower than this did not single out the ears; higher speeds forced the feed into the mill too rapidly. The drive for these feeders was taken from either the crib conveyor motor or a separate motor on the same control and thus stopped and started with the conveyor.

Blending Device. A blender was constructed and tested in the laboratory for metering the ration components of small grain and supplement (Fig. 2). Three cylinders were made of 8-in-diameter pipe, 8 in long. These were mounted between two sheets of steel plate. A cone of sheet metal was welded inside each cylinder at the bottom edge, and the top of the cone was cut off at a height of 4 in to allow a shaft to pass through the cylinder. A cone on the shaft overlapped the cone in the cylinder and was given enough clearance to rotate easily. Holes in the bottom plate beneath each cylinder permitted any material passing between these cones to fall into the feeder below.

The shaft in each cylinder carries rubber blades which are spaced laterally to divide the space within the cylinder into eight equal parts. Holes in the top plate, protected by pivoted, adjustable cover plates, allow material to enter each cylinder; these holes are above the rear of each cylinder. As the divisions on the revolving shaft fill at the back, rotation

*The agitator design was based on the thesis, entitled "Processing Ear Corn by Crushing and Grinding with Small Electric Power Units," by Russell H. Heston, Iowa State College, 1948.

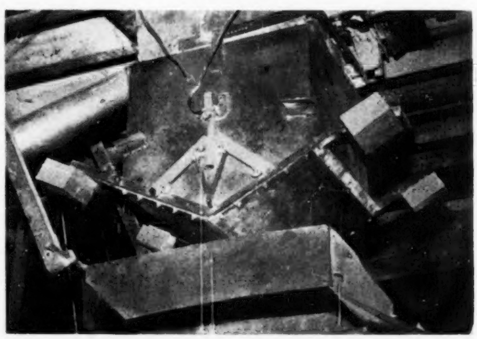


Fig. 3 The discharge bucket

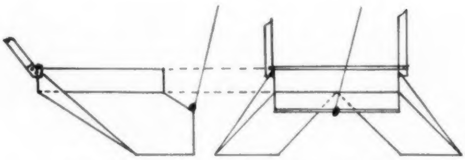


Fig. 4 Metal divider below bucket for wagon loading

carries the grain around to the front where it falls through a slot and into the feeder. The amount falling into the feeder is governed by the size of the gate which covers the front opening; the gates vary successively in length by ¼-in increments. Even feed is obtained, since the material falls from two or three divisions continuously. Output ranges are from 120 to 1,750 lb of shelled corn, 100 to 730 lb of oats, and 100 to 460 lb of supplement hourly. This variation allows for rations that range from 1-1-1, or equal parts of shelled corn, oats, and supplement, to 9-0-1 and 0-4-1. Two of the three shafts are driven from the third which gets its power from the ear-corn conveyor shaft.

The blender was installed at the Lynch farm and is now in operation. The feed-in arrangement consists of three compartments located above the blender. Shelled corn and oats are supplied through wooden chutes from 1,000 and 500-bu overhead bins, respectively. Pellets, supplied by a homemade elevator to a bin located above the metering device, provided the supplement for a ration. This bin has a front opening to facilitate checking the supplement supply as it requires more attention than the overhead bins.

Dust Control. The small dust collector furnished with the hatchet-type mill at the Lynch farm was inadequate. A larger one was made and placed above the supplement storage room. A 9-in pipe leads from the bottom of the dust collector to either the grain storage bin and sacking chute for ground grains other than corn-and-cob meal, or the corn-and-cob meal discharge bucket.

A storage chamber was mounted on the wall for holding 1,200 to 1,500 lb of ground grain. Combined with this is a double-outlet sacking chute, through which grain can be sacked directly from the mill. The storage bin has a hand-operated agitator to break up bridging. A pipe connected between the storage box, the discharge bucket, and the hammer mill intake hopper permits excess air to return to the mill, and reduces the dust caused by excess air velocity.

A discharge bucket (Fig. 3) was developed, and it was found to have a decided effect in controlling dust when grinding corn and cob meal, as it tripped once each 4 to 5 min. It also reduced to a great extent the separation of the meal, normally resulting when discharged from an open spout, and, with the addition of an electrically operated counter, fairly accurate information was obtained as to the amount of feed ground. The bucket holds approximately 125 lb and is adjustable to trip at any desired weight. A metal divider frame (Fig. 4) is provided beneath the bucket, which directs the ground feed toward both ends of the wagon box, thus doing away with the necessity of moving the wagon forward or backward as it is being filled.

Grinding Capacity. The Lynch farm grinder is of the hatchet type with the fan integral with the rotor. Tests indicate that with the heavier rotor and greater air delivery more energy is required to operate the empty mill than is required for one of conventional type. Capacity yields were satisfactory whether ear corn alone was being ground or small grains preblended and ground.

When grinding a complete ration consisting of shelled corn, whole oats and supplement, the usual procedure is to use a ¼-in screen in the mill, especially if the ration is to be fed to small pigs. On the Lynch farm this method of grinding gave a product with a fineness modulus of 1.70, with 28 per cent passing through a 100-mesh screen. To ascertain if pregrinding of oats would be of value, tests were run in which the oats were ground alone through a 3/16-in screen, and the ground oats introduced in the same ratio as before into the shelled corn and supplement before grinding, using a 1-in screen in the mill. The fineness modulus was raised to 2.60, with 8 per cent passing through a 100-mesh screen. A farm setup in which the last method was practiced would have to consider some means of agitation in the bin storing the ground oats.

The ration considered was 3 parts shelled corn, 2 parts whole oats and 1 part commercial supplement, or in a total of 6 tons of ground ration, there would be 3 tons, 2 tons, and 1 ton, respectively. The grinding of 2 tons of oats, at 500 lb per hr through a ¼-in screen would require 8 hr. Grinding the 2 tons of ground oats with 3 tons shelled corn and 1 ton supplement through a 1-in screen at 3,000 lb hourly would require 4 hr, or a total of 12 hr for the 6 tons. Production tests when grinding shelled corn, whole oats and supplement through a ¼-in screen repeatedly gave 750 lb hourly, or a total of 16 hr for 6 tons. Thus pregrinding of the oats reduced by 4 hr the time required to prepare 6 tons of feed, and, in addition, reduced by 70 per cent the amount of feed passing through a 100-mesh screen.

The difference in electrical energy consumption was slight, being only ½ kw-hr per ton in favor of the pregrinding method for the oats.

Motors and Power Source. The motor used to drive the hammer mill will have an effect on the performance of the mill. Because most farms are supplied with single-phase alternating current, only single-phase motors were considered. Due to the need of essentially a constant-speed drive for a hammer mill, the selection of a motor is practically limited to an induction motor. In addition the motor must have a fairly high starting torque, low starting current, and high running torque in order to recover from overloads as quickly as possible.

Capacitor-start induction motors are now available in sizes of 5 or 7½ hp and these may be used for driving the hammer mill. One such motor was tested to determine its performance in comparison with repulsion-induction motors. This particular motor was of the capacitor-start induction-run type and had a centrifugal switch for disconnecting the capacitor and starting winding when near running speed has been reached. The motor had a relatively high starting current (125 amp) and had very high current requirements on moderate overloads. Current values on overloads frequently were as high as 40 amp and occasionally reached 80 amp. This is undesirable from a practical standpoint because it means that either larger conductors are necessary to maintain the voltage required for quick recovery or poor performance will result. Tests indicated that the capacity of the hammer mill was decreased appreciably when this motor was used as compared to other motors. Such demands on the line would in many cases result in lamp flicker and might require rewiring of buildings and the installation of a larger transformer in order to maintain a satisfactory voltage.

Tests were also made using repulsion-induction motors. These in general were more satisfactory than the capacitor-start motor. One motor had a very high current requirement at no load and this sometimes caused improper operation of the overload relay since the no-load current of the motor was very near the cutoff value of the relay.

The motor which gave the best results was a high-torque repulsion-induction motor. The production obtained through the use of this motor was the highest obtained for any of the motors tested and the peak current values were less than those resulting from similar overload conditions on other motors.

Controls and Protective Devices. The design of control and protective equipment is generally dictated by necessity. For this reason it is desirable to have a clear statement of the problem involved before an attempt is made to solve it. The problem here is to regulate the feeding of a hammer mill to maintain full-load conditions on the driving motor. It is necessary to prevent overloading in the interest of economy and longevity of the driving motor as well as obtaining uniformity of product. It is necessary to prevent underloading if the maximum capacity of the machine is to be realized. The accomplishment of this objective along with protection of the machine in the event of improper operation, all without the attention of an operator, requires an automatic control device

which is reliable. Further requirements of the controls are that they be simple to operate, long lived, and low in cost. Equipment on the farm is often called upon to operate under extreme conditions of heat, cold, dust, and sometimes neglect.

The action of an automatic control is dependent upon some characteristic of the controlled machine which varies with the conditions imposed upon it. If it is desired to maintain full load on the feed grinder, then we must select some characteristic of the machine which varies with the load. When a hammer mill is driven by a single-phase induction motor, the speed, power input, power factor, and current all vary with the load. In addition the torque required to drive the mill varies with the load. It would be possible to use any one of these characteristics to obtain the control needed but some are more advantageous than others. The power factor is a double-valued characteristic and a device capable of differentiating between these two values on the load curve of a motor would be complicated. The variation of speed with load is quite small until a condition of severe overload is reached and a control operating on this characteristic would not act quickly enough unless it were very sensitive. Centrifugal switches have been used to some extent for this purpose, particularly in industry, but the high cost of these devices along with other disadvantages make them impractical for this application. The speed of an induction motor varies for a given load with variations in voltage, and this would be somewhat disadvantageous when using a centrifugal switch since the point of operation of the switch would change frequently with respect to the load.

It is conceivable that the change in torque with load might be used to regulate the rate of feeding of a hammer mill, but the accomplishment of this is difficult. Probably the simplest way of doing this would be to mount the motor in a cradle and use the deflection of the mounts to operate the switch for the feeder motor. The inertia of the cradle motor would undoubtedly slow the action of this type of control and would give a wide differential between off and on positions of the conveyor switch. It would also involve some exposed mechanical linkages which would be susceptible to dirt, dust and foreign materials. Some difficulty might be encountered in enclosing the machine to prevent the interference of foreign materials, and this in addition would hamper field adjustments of the operation of the control.

PARTICULAR ADVANTAGE OF THE INDUCTION MOTOR

The change in current with load on an induction motor is the most promising characteristic which can be used as a means of control. An induction motor tends to run at a constant speed, and if the load placed upon it increases, it quickly demands more power from the line in an effort to maintain its speed. This means that, if a constant voltage is applied, the current will vary approximately in direct proportion to the load. In general, the current required by a single-phase induction motor is a single-valued function except at starting. It is true that some single-phase motors, particularly the repulsion-induction types, have relatively high current requirements at no load, and of course some of these motors cannot be used with this type of control. A device operating on the changing current principle is relatively simple to design and to use and the cost is not prohibitive.

The remaining controls present somewhat less of a problem than the automatic feeding control. Adequate protection must be provided for the motor driving the hammer mill. The switch for the conveyor motor must withstand frequent starts and stops and for this reason must be made of high quality materials and of such design that the moving mechanisms will act freely and positively. This switch may have to perform as many as 30 complete operations per minute.

Load Regulation Control. Electric controls for the test installations were designed or selected to meet the foregoing requirements and characteristics. A single-phase motor starting switch of the magnetic-relay type with both overload and undervoltage protection was used to start and stop the entire machine. The hammer mill motor only was connected through the protective devices, however. A second magnetic-type starting switch was selected for the operation of the conveyor motor, and it included the same protective features as the first switch. The device chosen to control the feeder motor was a magnetic overload relay consisting of a solenoid and a microswitch. The entire current supplied to the hammer mill motor flows through the solenoid. When a current greater than a predetermined value is required, the plunger of the solenoid is lifted and the microswitch opens, stopping the conveyor motor. When the load and the current decrease, the solenoid plunger returns to its normal position closing the circuit to the conveyor motor. This electromechanical device is fairly rugged, but does have some disadvantages. The microswitch is rather delicate and unless completely enclosed from dust and dirt will have to be cleaned periodically. The particular unit selected for these tests did not always function at very low temperatures and some adjustment was necessary. The plunger has appreciable inertia and the switch was not opened on high rates of current increase at the current value at which it was set. A characteristic of the device used which affected the production of the grinder was the wide differential between the value at which cutoff occurred and the value at which the plunger returned to normal position. At 30 amp the differential was approximately 7 amp, which means that the motor current had to decrease to 23 amp after an operation of the control device before the conveyor motor could start again. Because of this condition, the mill was permitted to run very nearly empty for a short period of time before feed was again supplied by the conveyor. In addition to the fact that production was somewhat less than might be possible, the wide variations in load sometimes caused enough variation in line voltage to produce noticeable lamp flicker.

POSSIBILITIES OF ELECTRON TUBE INVESTIGATED

Some work has been done to investigate the possibilities of using an electron tube to overcome some of the disadvantages of the solenoid relay. One such relay was designed and preliminary field tests indicated that it had a considerably smaller differential (approximately 50 per cent) between cutoff and cutin values than the solenoid relay and the entire relay action was accomplished by the tube, eliminating nearly all inertia effects. This particular relay would not be affected by temperature variations normally encountered on the farm, and the only moving part, a small high-sensitive relay, could be completely enclosed without affecting the operator's ability to change the adjustment for the operating current of the motor. The output of the mill was increased approximately 10 per cent with electron-tube control as compared to output with the solenoid relay control.

Agitator Control. If a machine is to be entirely automatic in operation, it must be able to provide for all eventualities in the absence of an operator. The agitator in the ear corn storage bin, described previously in this paper, required a means of control. When bridging occurred, no corn was fed to the mill and the 5-hp motor was not loaded. A time-delay relay was connected in the conveyor motor circuit to operate only when the conveyor motor operated. After a short period of continuous operation, with no corn being fed into the mill, the time-delay relay closed the circuit of the agitator motor. The agitator continued to operate until an overload condition occurred at the mill when the time-delay relay automatically reset. The particular device used consisted of a spring-loaded cam driven by a small hysteresis motor, and a microswitch. The cam automatically resets to zero each time the solenoid control stops the conveyors.

Protection from Improper Operation. A second time-relay was used to interrupt the circuit of the main-switch holding coil in case the conveyor operated for a long period of time without an overload occurring. The motor of this relay was connected in parallel with the agitator relay and the two ran simultaneously. The time interval of the second relay was considerably greater than the time interval of the agitator relay to permit functioning of the agitator before stopping the entire machine. The second relay operated when anything happened which might prevent corn from being supplied to the grinder, such as a broken conveyor chain, stalling of the conveyor motor, stalling of the agitator motor, operation of the overload protection of the conveyor motor, plugging of the

mill throat, shearing of a pin in the conveyor shafts, or practically any malfunction of the conveyor mechanism. The relay also protects against breakage or slippage of the belts between the 5-hp motor and the hammer mill. It does not provide protection for stalling of the motor, but the overload device in the starting switch will take care of that, should such occur.

In all automatic installations a magnet in the grain spout or mill throat is essential for protection against foreign metal objects.

Cycling. If completely automatic operation of the grinding unit were to be achieved, this would mean grinding the feed as needed without the attention of the operator. This might be accomplished in a number of ways — for example, using a time clock to start the mill, let it operate long enough to grind the daily feed requirement, then stop automatically. This method has the one advantage in that the operator need not attend the machine from day to day, but it also has certain disadvantages. There is always danger of foreign materials getting into either the grinder or conveyor mechanism while in operation or during the idle periods. Wear occurs making necessary the tightening of belts and chains; bearings need oiling and many things could happen which might endanger the equipment or the building in which it is housed. For this reason and many others, it was felt that the operator should be present to start the grinder and see that it is functioning properly before leaving it to work by itself. Means have been used to automatically stop the mill after the desired quantity of feed has been ground. An interval timer was connected in the holding-coil circuit of the main starting switch so that when the operator set the timer for the length of time desired, the mill started and continued to run until the time had elapsed. This relieved the operator of the necessity of returning to the unit after sufficient feed had been ground.

A second system which is almost as convenient to use as the one just described is the use of a switch attached to a scale beam. In one instance where a platform scale had been installed in the driveway of a crib, a microswitch was mounted so that when the scale beam balanced the switch opened, breaking the circuit of the main switch holding the coil. In order to start the machine, the wagon used to haul the ground feed from the grinder to the feed bunks was placed on the scale platform. The operator then set the scale for the desired weight of feed to be ground and started the machine. The mill automatically stopped when the predetermined quantity of feed had been ground. This system is more desirable than the previous one in which the interval timer was used because it can accommodate the different rates of grinding which may prevail when varying amounts of husks, shelled corn, moisture and other indeterminate factors are present.

SUMMARY AND CONCLUSIONS

1 It is entirely practical to utilize automatic processes to remove ear corn and small grain from storage, and feed it into a 5-hp electrically operated hammer mill at a rate controlled by the load condition of the 5-hp motor in such manner that the operator need not be present while grinding.

2 The capacity of automatic grinder installations tested under farm conditions ranged from 1,000 to 1,500 lb of ear corn per hour, varying somewhat with the local voltage condition and the quality and moisture content of the grain.

3 While high capacity and low power costs are desirable, the dependable, unfailing operation of the automatic feed grinder is the primary criterion. High output per hour is not a necessity since the operator need not be present. Elimination of most operator labor reduced the total calculated cost of grinding well below other methods, even with the lowest capacity obtained.

4 An auger feeder has proven satisfactory for carrying ear corn from the crib discharge and grain ration components from the blending device to the hammer mill.

5 Bridging of ear corn in the crib was overcome by the installation of a relatively inexpensive device which operated when corn failed to feed into the hammer mill.

6 A fluted wheel metering device proved satisfactory for delivering small grains and supplement to the hammer mill where the ration is mixed as it is being ground.

7 Dust can be controlled from small hammer mills that deliver excess air by building a closed system and venting the top of the dust collector or storage bins to the intake side of the hammer mill.

8 Laboratory tests indicate that some types of single-phase, 220-v, 5-hp motors are better suited for the operation of these automatic grinders than others. The motor giving the highest capacity and the lowest power consumption was a repulsion-induction, high-torque motor. The capacitor motor was used and did not prove satisfactory because of the high current demand when starting and during overload conditions.

9 The electrical load characteristics of small hammer mills grinding ear corn varies widely with the individual mill design. The following observations are based on tests of automatic ear corn grinding where feeding is controlled by the current input to the driving motor: (a) Hammer mills in which the rotor, hammers, and moving parts have high mechanical inertia give a flywheel effect that delays the inrush of high current thus allowing a heavy overload to accumulate in the mill chamber. When the current inrush does stop the feeder the motor must clear the mill and recover all the lost mechanical inertia before the conveyors are restored to operation. (b) In comparing the two swinging-hammer-type mills, the mill having thinner hammers and a wider rotor created less serious overload conditions with ear corn, and produced a more uniform product. There appears to be a need for further study on the comparison of hammer thickness and grinding chamber width before definite conclusions can be reached. (c) The remodeling of the throat and addition of the expansion chamber on the swinging-hammer type mill increased the capacity and reduced the severity of overload conditions. (d) The possibilities and advantages of a completely redesigned hammer mill with a controlled auger feeder at floor level and the screen above the hammers appear to justify further investigations, both in small electric-driven mills and larger tractor-powered mills.

10 The use of small electrically powered feed grinders is practical and can be made automatic in operation with proper controls. The controls must insure normal operation of the grinder and must protect it and the surrounding equipment against malfunctioning of any part of the unit. It is not desirable to attempt automatic starting of the grinder but automatic stopping of the machine is safe and reliable. The cost of existing controls which may be used for automatic operation is not unreasonable, and the cost of developing controls particularly for this purpose should not be excessive. Electron tubes may be used to replace some electromechanical devices, increasing the life, performance, and reliability of those devices.

Agricultural Engineer Writes from Ceylon

EVAN A. HARDY, on leave as head of the agricultural engineering dept., University of Saskatchewan, to serve one year as leader of the FAO technical team in Ceylon, writes as follows:

"We are enjoying the work here in Ceylon where there are many acute problems related to engineering in agriculture. I have just been assisting in putting on a short course in the use of farm implements. We were dealing primarily with tillage and transplanting problems, with a little bit of surveying.

"The problems in the dry zone, with which I am particularly concerned, are much more difficult, because rainfall distribution is extremely poor, being concentrated primarily in October, November, December, and April and May, with practically no rainfall through June, July, August and September. The soil becomes extremely hard and must be prepared for seeding when dry. The native normally leaves this preparation until the first rains in October, and for that reason is able to put in a crop on only a very small area before the continuous rains start.

"We are experimenting with cover crops and various types of machines to conserve more moisture during the summer so as to keep the soil in condition where it can be worked and a crop put in ready for growth before the heavy rains in October.

"The FAO work here is very interesting. I am the leader of all the FAO work; consequently I am interested in more than just the engineering problems. We have an expert in sugar cane and specialists in soil chemistry, animal husbandry and fisheries, and have two other experts coming, one an agricultural statistican and the other a chemical engineer interested in synthetic fertilizer production."

Mechanical Ventilation of Stored Grain

By R. N. Robinson, W. V. Hukill and G. H. Foster
ASSOCIATE MEMBER ASAE MEMBER ASAE MEMBER ASAE

WHERE grain is stored in large bins a seasonal moisture migration occurs. Damaging accumulation in the surface layers has been observed even with grain otherwise sufficiently dry for safe storage. In the fall and winter when the bin wall and the grain near the wall becomes colder than the grain at the center of the bin, convection currents within the bin are created which result in the transfer of moisture from the comparatively warm central mass of grain to the cold upper surface around the center of the bin. The slowly upward moving air in the central portion of the grain mass rises in temperature from contact with the comparatively warm grain and at the same time the absolute humidity of the air is increased by moisture removed from the grain. When the rising air comes in contact with the cold grain near the top surface, some of the moisture condenses out of the air, thus raising the moisture content of the top layer of grain without increasing the net moisture content of the whole mass of grain; in fact, there is actually a slight decrease in moisture content from some distance below the surface down to the floor.

Previous Investigations. The relation of convection currents and moisture accumulation was demonstrated by an experiment set up in the spring of 1943 on the Commodity Credit Corporation bin site at the Iowa Agricultural Experiment Station at Ames. In this case a 2740-bu circular steel bin was filled with corn to a depth of approximately 9½ ft; then a sisalkraft paper moisture barrier was laid over the entire leveled surface. An additional 3-ft depth of corn was placed on top of the moisture barrier. At no time during the following winter and spring of 1944 was any appreciable increase in moisture observed at the surface of the corn. In May, 1944, the corn on top of the moisture barrier was removed and the corn below the barrier was examined. It was found that there was a great increase in moisture content adjacent to the bin wall immediately below the moisture barrier. This indicated that the rising air currents at the center of the bin moved horizontally when reaching the moisture barrier until reaching the bin wall. On coming in contact with the cold corn near the wall, moisture was condensed from the air.

This paper was prepared expressly for AGRICULTURAL ENGINEERING and is based on a study carried out jointly by the Bureau of Plant Industry, Soils and Agricultural Engineering, Bureau of Entomology and Plant Quarantine, Production and Marketing Administration of the U.S. Department of Agriculture in cooperation with the Iowa, Indiana, Illinois, Minnesota, and Kansas agricultural experiment stations.

The authors: R. N. ROBINSON, W. V. HUKILL, and G. H. FOSTER, agricultural engineers specializing in grain storage research, U.S. Department of Agriculture.

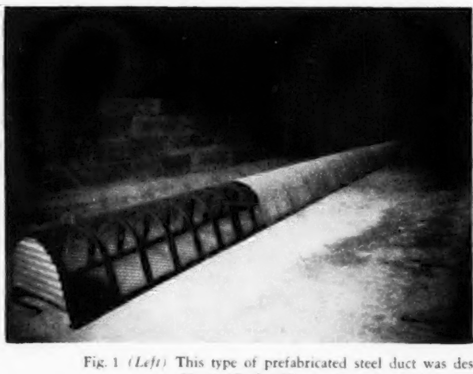
The moisture accumulation resulting from this seasonal moisture migration is high enough and extensive enough to result in considerable damage. Bins have been observed wherein 45 to 50 bu of grain were completely spoiled in a centrally located area about 10 ft in diameter (in a 2740-bu, 18-ft-diameter bin) and from 6 to 9 in deep. There is a degree of redistribution in the spring and summer with the moisture content at the top becoming lower, but frequently the moisture content remains high after the weather has become sufficiently warm for the development of molds. Moreover, this grain with a high moisture content favors the development of destructive insect infectation, and it will become caked and greatly retard any air circulation through it.

A report (not published) by George W. French of the Bureau of Plant Industry, Soils and Agricultural Engineering describes tests at Ames, Iowa, in which corn in a 2740-bu bin was cooled by forcing atmospheric air through the grain. This was done during the winters of 1944-45 and 1945-46 in a circular steel bin, 18 ft in diameter and about 13 ft high. A plenum chamber 7 ft square and 6 in deep with a top of hardware cloth was installed on the floor in the center of the bin. A fan outside the bin was connected to the plenum by a rectangular duct so that air could be forced upward through the grain. The first season air was supplied at a rate of about 2300 cfm, or about 0.84 cfm per bu. Eighteen hours of ventilation during December with atmospheric temperatures ranging from 2 to 15 F reduced the average grain temperature to about 20 F. The maximum surface moisture content after cooling was 13.4 per cent, the average for the bin being 12.3 per cent.

In the second season the bin was again ventilated. Nine and one-half hours of ventilation at a rate of 1.2 cfm per bu during October and November with atmospheric temperatures from 30 to 50 F reduced the average grain temperature to about 43 F and 33½ hr ventilation during December at a rate of about 0.5 cfm per bu with outside temperatures from −5 to −14 F reduced the central grain temperature to about 16 F. The highest moisture content reached the second season was 14.1 per cent. The top layer moisture in the similar unventilated bins frequently reaches 20 per cent or more in January.

It was observed that, when the blower was operated during freezing weather, a layer of frost accumulated on the underside of the roof. The frost later melted and dripped onto the corn but did not cause noticeable damage.

Results of Recent Observations. Moisture migration is more pronounced in large bins than in small ones. When the government took over large quantities of shelled corn in 1949,



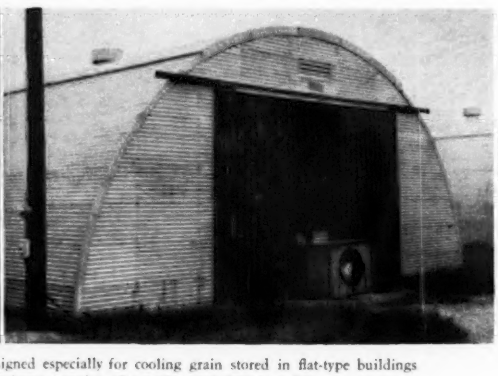


Fig. 1 *(Left)* This type of prefabricated steel duct was designed especially for cooling grain stored in flat-type buildings
Fig. 2 *(Right)* The mechanical ventilation equipment used in the cooling and drying studies

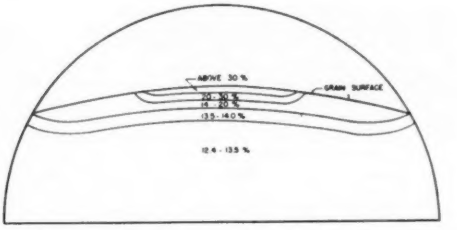


Fig. 3 Moisture contours illustrating the extent of moisture accumulation in the surface layers of stored grain

much of it was stored in buildings holding 20,000 bu or more. Anticipating serious increases in the moisture content in the upper layers, many of the larger buildings were equipped for mechanical ventilation with cold air. A duct was installed along the center line on the floor. The walls of the duct supported the corn but were open enough to permit air movement through them (Fig. 1). Fans were installed of a capacity to draw a minimum of 0.1 cfm of air per bu through the corn (Fig. 2). Higher and lower volumes were used in a few bins. The fans were operated to draw air downward through the grain although a few were put in position to force the air upward for comparative observations. About the same quantity of air was moved in either direction, but downward air movement was preferred because upward moving air would contact cold grain and the cold roof, resulting in some condensation. With the air moving downward and out of the tunnel, it would not become cold until it left the bin.

The ducts of some of the bins that had been cooled were sealed and others left open after the weather warmed up. The grain in those with the ducts open warmed up much more quickly. Some of the duct ends were insulated as well as being closed, but this made no noticeable difference.

Extent of Moisture Accumulations in Larger Storages. The more important factors affecting the amount of moisture migration and accumulation include (1) the average moisture content of the stored grain, (2) the size of the storage, (3) the length of the storage period, and (4) atmospheric and grain temperature differences. Observations on grain condition in CCC storages in Kansas, Minnesota, Iowa, Illinois and Indiana in 1949 and 1950 confirms previous observations that 13 per cent moisture content of shelled corn is about the maximum limit for storage periods of one year or more. Even with this dry grain, there was damage from moisture accumulation sufficient to lower the grade of the corn stored. Although the damage was confined to the grain in the surface layers, a lowering of grade was effected when this damaged grain was mixed with the other grain in the storage. The damage from this cause was not so great in the smaller metal bins of 3200-bu capacity, and in the yet smaller wood bins, the amount of damage was generally insignificant. In all storages containing shelled corn at moisture levels of 13 to 14½ per cent, the extent of damage was considerably greater. Studies carried through the second storage year showed the moisture accumulation to be much more severe the second year after the maximum temperature differences became established within the grain mass. The corn had been shelled and put in the bins in the fall when its temperature was relatively low. If it had been put in the bin hot, no doubt the moisture transfer would have been as severe the first year as the second.

Observations in 25,000-bu flat-type storages at a Commodity Credit Corporation bin site near Lafayette, Ind., have indicated that as much as 400 to 500-bu of corn can be seriously damaged by moisture migration in this size and type of storage during the second storage year. The extent of moisture accumulation is illustrated in Fig. 3 for one typical flat-type storage. The most serious increase in moisture content occurs in surface layers of grain in the central portion of the storage. This increase may cause damage to the grain to a depth of 1½ ft or more. Table 1 represents the damage observed in one

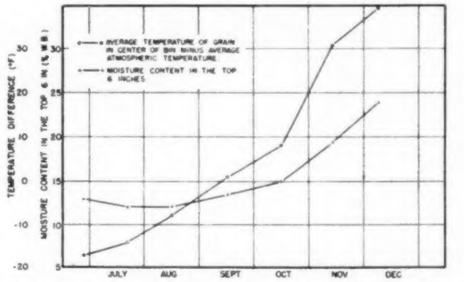


Fig. 4 Moisture accumulation in the surface layer and the difference between grain and atmospheric temperature

building during the second storage year where the average grain moisture content is about 13 per cent.

TABLE 1. GRAIN DAMAGE DUE TO MOISTURE ACCUMULATION

	Per cent damage	Grade No.*
Top 5 in	60	Sample
5 — 10 in	30.8	Sample
10 — 15 in	8.6	4
15 — 25 in	5.1	3
25 — 35 in	2.8	1
35 — 45 in	1.7	1
45 — 55 in	1.2	1

*Official grain standards of the U.S. Department of Agriculture

As the previous studies have indicated, an increase in moisture content in the surface layer of grain is first noticed in the late summer or early fall. The relationship between moisture content in the surface layer and the difference in atmospheric and grain temperatures are shown in Fig. 4. In this instance an increase in surface moisture was first recorded in early September. With drier grain the surface moisture accumulation may not become serious until October or later, depending on weather conditions.

Effectiveness of Mechanical Cooling in Preventing Moisture Accumulation. The results of the work at Lafayette, Ind., to determine the effectiveness of cooling as a control for moisture movement have shown (1) that temperature control of the stored grain with mechanical ventilation effectively reduced the migration of moisture to the surface layers of the grain, (2) that it is desirable to start ventilation early in the fall, especially with grain moisture level slightly above the safe-storage limit, and (3) that continuation of ventilation through the winter is not necessary after the grain has once been cooled to near the freezing point. The time required for ventilation varied with atmospheric temperature and air flow; however, the average grain temperature in one 25,000-bu quonset was lowered from 54 F to 22 F with 71 hr of ventilation. The average atmospheric temperature during the cooling period was 17 F. Air was supplied at the rate of about 0.25 cfm per bu. The cooling equipment used was a 27-in six-bladed fan driven by a 1½-hp electric motor. Effective cooling has been obtained in Iowa tests with 1/10 cfm per bu; in fact, even lower rates of air flow would likely be satisfactory.

The comparison between the moisture content of the surface layers in similar ventilated and unventilated flat-type storages is shown in Fig. 5 and illustrates the control over moisture movement that is possible through ventilation.

Summer Ventilation for Drying. Satisfactory drying of shelled corn with a moisture level 1 to 2 per cent above the safe storage level was accomplished by drawing natural air through the corn in the summers of 1950 and 1951. Using ¼ to ½ cfm per bu about two months of controlled ventilation reduced the moisture content 1 to 2 per cent. Similar observations were not made on wetter corn, but it might be expected that such low volumes of air would be inadequate if the grain moisture is over 1 to 2 per cent too high.

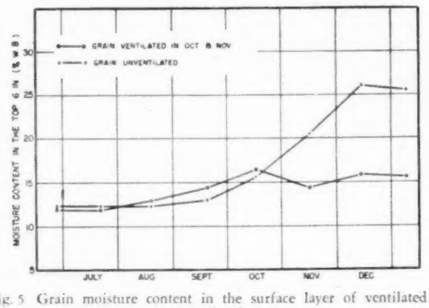


Fig. 5 Grain moisture content in the surface layer of ventilated and unventilated grain

Both 3200-bu circular bins and 25,000-bu flat storages were dried in this manner in Indiana studies. The cost of energy for lowering the moisture content 1 to 2 per cent was less than ½c per bu.

The fan equipment is the same for drying as for cooling, but a longer period of operation is required. In the large flat-type storages the air was drawn down through the grain thus taking advantage of the radiant energy from the sun that was absorbed through the roof. With the low ventilation rates and with the operation of the fan limited to periods when the relative humidity of the atmosphere was 70 per cent or less, the temperature of the drying air was increased 10 F from the solar heat absorbed through the roof.

The progress of drying in a 25,000-bu flat storage is shown in Fig. 6. During the first period, the fan was controlled by a humidistat suspended from the roof of the building about 4 ft above the corn. The humidistat was set to turn the fan on when the relative humidity of the atmosphere dropped below 70 per cent, and off when above 70 per cent. However, the humidistat contained a wood sensing element which lagged the rise in humidity at night and usually turned the fan off from 2 to 4 hr after the humidity reached 70 per cent. With the fan controlled in this manner, the corn in the top surface layer was lowered to 10.6 per cent with little drying in the lower layers. In period 2, the humidistat setting was increased to 85 per cent, and during the last 8 days, the fan was operated continuously. Under continuous operation the surface layer increased to 12.4 per cent moisture. Since the normal average relative humidity in much of the corn belt from May to October is sufficiently low to reduce the moisture of stored grain to a safe moisture level, continuous fan operation without automatic control might be effective most seasons. It would probably be advisable to turn off the fan during periods of unusually high humidity. Drying can be accomplished more economically by limiting the fan operation to periods of low relative humidity. As Fig. 6 shows, this results in overdrying in the upper layers. However, if the grain is to be left in storage, the overdrying is not serious and will tend to offset later migration of moisture to the top.

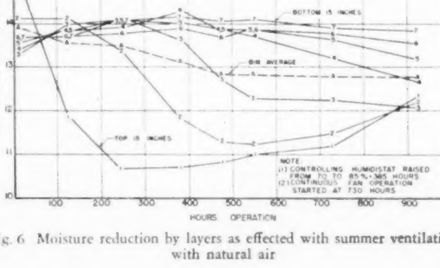


Fig. 6 Moisture reduction by layers as effected with summer ventilation with natural air

During the initial stages of drying cold corn with warm air, most of the energy in the air will go towards warming the grain to the drying temperature. An increase in grain moisture will occur under those conditions, as described by Theimer in AGRICULTURAL ENGINEERING for February, 1951. This is not considered serious provided the ventilation is continued until the desired amount of drying is accomplished.

Low-volume ventilation equipment offers an effective and inexpensive means of controlling moisture migration in stored grain by operation during cold weather and of reducing the moisture of the slightly damp grain by operation during the summer.

Underfloor Heat Brooder

By M. O. Whithed
MEMBER ASAE

AN electric underfloor heat brooder, using soil heating cable as the source of heat, which we have developed in southern New Jersey, has proven successful. There are several reasons why we chose this approach to electric brooding.

First, having worked with soil-heating cable for a number of years in electric hotbeds and having wonderful success with it, we believed that by burying this cable in concrete a brooder could be developed that would maintain a warm, dry floor. With the present-day brooder this is almost impossible to do. The moisture factor alone has done more to discourage electric brooding than any factor I know about.

Second, during the years of work with electric hotbeds we developed a seal for the ends of our cable which could be buried in the floor itself with assurance that it would last as long as the cable or the floor. This seal is protected by the patent laws of the United States.

Third, we knew that, if such a brooder could be developed, the stored heat in the floor would carry the poultryman over a normal power interruption, which is a big sales feature. With this in mind there was designed and built, as far as we know, the first all-electric underfloor heat brooder. That was seven years ago.

In April, 1950, we released the first publication on this brooder. At that time we had about 8 or 10 units in operation. Since then we have installed about 80 units with a total brooding capacity of about 45,000 birds. The largest installation has a capacity of 9,000 birds. This brooder can be installed on a small or large poultry farm with the same high degree of efficiency. There seems to be no place where it cannot be installed. It has been used on all types of poultry. Our mortality losses have run less than 1 per cent. It produces a dry, warm floor; a healthy, well-feathered, even-growing bird, and takes no oxygen from the air. It is safe in operation and labor saving. There is no fire hazard and it is thermostatically controlled, being as economical to operate as any competitive fuel. With all of these advantages we also have the advantage of cold room brooding.

It is only fair to say that the only disadvantage the poultrymen can find with it is that after it is once installed it cannot be moved. As for operating costs, they have varied depending upon the weather condition, averaging from between less than ½ kw-hr per bird to 1 kw-hr per bird.

What are the possibilities of this brooder? From the inquiries we have received from all over the United States, Canada, and Great Britain I would say there are many. It is interesting to note that the majority of these inquiries are from the utility field, leading us to believe that everywhere there is some alarm over the trend of electric brooding.

One of these units, using 120 ft of cable at 240 v, will heat a floor area not greater than 25 sq ft. In the majority of cases two such units are connected to *(Continued on page 611)*

This paper was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1950, as a contribution of the Rural Electric Division.

The author: M. O. WHITHED, senior rural representative, Atlantic City Electric Co., Atlantic City, N. J.

Selection and Application of Asphalt Roofings for Farm Buildings

By James L. Strahan
FELLOW ASAE

THE function of any roofing material is to keep the weather from penetrating through to the roof deck.

No matter what material is used, it must perform this minimum essential function; but it must do so at reasonable cost; it must do so regardless of the slope or pitch of the roof deck; it must do so whether the deck has a plane or a curved surface; it must do so regardless of whether the structure is in a protected location or is exposed to high winds. Finally, the roofing should provide an adequate degree of fire resistance. This latter is particularly important in the case of farm buildings because they are not ordinarily close to fire-fighting apparatus.

It will be of interest to consider asphalt roofings in connection with these important use requirements, as follows:

Cost. The cost, both to purchase and to apply, compares favorably with any other roofing material. But still more important, the wide range of choice in asphalt roofings available to the consumer provides an opportunity to adjust the cost to the economic importance of the structure. A building whose function does not warrant the expenditure of large material costs can be roofed with an inexpensive roll product which will successfully perform the essential weatherproofing duty for as long a time as it is needed. On the other hand, a heavier type asphalt product designed for longer service can be selected for use on a dwelling or large service structure which requires and can afford such a long lived roofing material.

When it is considered that asphalt roofings are available in weights ranging between a minimum of 45 lb per square and a maximum of 325 lb, it is obvious that there is a very wide choice from which to select a product which is best suited both to the economy and to the functional requirements of any individual construction project. This is probably one potent reason why the asphalt roofing industry currently supplies upward of 85 per cent of all the roofing shipped annually in the United States. Versatility is a really important characteristic.

Pitch. There are certain physical limitations that must be recognized in the selection of an asphalt roofing; limitations imposed by the pitch of the roof deck. Fig. 1 indicates the recommendations of the Asphalt Roofing Industry Bureau with respect to pitch limitations. A flat deck requires a roll product or a built-up roof. Shingle products are suitable for decks having a pitch of 4 in per ft of run or over, and with this low pitch (4 in per ft) it is desirable for the head lap of the shingles to be increased.

"Head lap" is important because it reflects the ability of the material to turn back driving wind-swept storms. It has been defined as "the shortest distance the weather will have to travel in a direction perpendicular to the eaves of the roof in order to penetrate through to the deck." In the case of three-tab, square, butt-strip shingles laid in the normal fashion it is the distance from the top of the cutouts in any course to the top edge of the shingles in the course next below, or 2 in.

Fig. 2 shows how decreasing the exposure of 12-in-wide strip shingles from 5 to 4 in automatically doubles the head lap; increases it from 2 to 4 in. In order to get an idea of how to evaluate the increased weather resistance thereby developed, it is convenient to conceive of the slope distance of the head lap as having a vertical and a horizontal component, and of the vertical component as representing the "head" against which the weather must operate in order to penetrate to the deck. In Fig. 2 this vertical component has been designated h.

It is to be observed (upper drawing, Fig. 2) that the value for h on a slope of 4 in per ft is only about half of what it is on a slope of 8 in per ft. As the slope increases, the weather resistance of a given head lap increases also, and vice versa. Therefore, in order to compensate for the reduced resistance which occurs on low pitches, it is desirable to increase the head lap by an appropriate amount. When the shingles are exposed 4 in instead of 5 in as shown in the lower drawing, the value of h on the 4-in pitch is just about the same as when the shingles are exposed 5 in on the 8-in pitch, and the weather resistance will be virtually the same in both cases.

Flexibility. Asphalt roofings are flexible. They will conform themselves easily to any surface on which they may be applied. They can be made to lie tightly against a plane surface or a curved surface. But because they are made largely of a thermoplastic material they cannot be expected to serve well on a surface that provides only a partial support, as, for instance, shingle lathe. They must be applied to a tight deck.

Many people ignorantly use the term "tar paper" when referring to asphalt roofings, probably because paper is flexible. Asphalt prepared roofings are not made of tar, nor are they built on paper. They are made by impregnating a relatively thick felt with a specially prepared asphalt saturant, and by covering the saturated felt with a somewhat different type of coating asphalt in which is embedded mineral surfacing granules of various colors and color combinations. The felt is made from animal and vegetable fibers formed into a blotter-like fabric varying in thickness from 25 to 60 or more thousandths of an inch, and weighing from 26 to 80 lb per 480 sq ft. This is equivalent to from 5.2 to 16.6 lb per 100 sq ft. The finished products made on these felts weigh from 40 to 110 lb (or more) per 100 sq ft, and when cut into roll roofings or shingles and applied on a roof deck will weigh anywhere from a minimum of 45 lb to a maximum of 325 lb per square. As used here the term "square" is meant the amount of material which, after being applied, will cover 100 sq ft of roof area. Only about one-eighth—or less—of the finished product is felt. The balance is asphalt and mineral granules, the real weather and fire-resistant elements of the roofing. The felt is the frame work which holds the weather and fire-resistant materials in place on the deck. The term "tar paper" is definitely a misnomer.

While the characteristic of flexibility enables the roofing to adjust to different surface varia-

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The author: JAMES L. STRAHAN, technical director, Asphalt Roofing Industry Bureau, 2 W. 45th St., New York 19, N. Y.

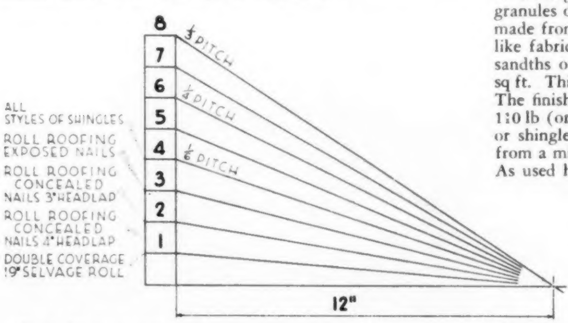


Fig. 1 Minimum-pitch requirements for asphalt roofings as recommended by the Engineering Committee of the Asphalt Roofing Industry Bureau

tions on the deck, and renders practicable the use of built-in interlocking devices in shingle designs, it also imposes certain important application techniques to insure stability on the deck under all weather conditions. Nailing is most important, and in some instances the use of quick-setting asphalt cement is very desirable.

Nails. The number and spacing of nails is usually specified by the manufacturer and included in the direction sheets provided with the roofing material. Many manufacturers recommend the use of 6 nails per strip when applying three-tab, square butt strip shingles. Others feel that four are sufficient, especially when the free tabs are later to be secured with quick-setting cement. There is a tendency on the part of some applicators to use as few nails as possible. This is particularly true in what might be called mass-produced, small-home developments. Of course, the object is to reduce costs, but all too frequently what is the contractor's gain is some other person's loss, because later maintenance costs of wind-damaged roofs bear heavily on both home-owners and insurance companies. It does not pay to save on nails.

Quick-Setting Cement. An asphalt cement having the quality of setting rapidly and developing a very firm bond between two sheets of roofing has recently come into general use as an adhesive to supplement nails in securing roofing products applied in locations subject to high winds. Two applications are particularly worthy of note, as follows:

(1) *Blind-Nail Application of Roll Roofings.* Fig. 4 shows a detail representing a preferred method of applying roll roofing. The principal feature is the method of securing lap joints, both horizontal and vertical. Nails are used to hold the underlying course to the deck while quick-setting cement, spread over the entire lapped area, and covering the nail heads, is used to secure the overlying course. When the two layers are firmly pressed together, a joint is developed strong enough to resist all weathering stresses that are likely to occur including high winds. This method of application completely eliminates the creeping of nails which frequently occurs when nails are exposed, and also does away with leak hazards at nail locations because there are no punctures through the exposed surface. When used in locations where high winds are likely to occur a further precaution is to lay the roofing in 18-in widths instead of 36-in, and using a head lap of not less than 3 in. It will require more material to cover the same area, but the added security will more than repay the extra cost.

(2) *Cementing Tabs of Strip-Type Shingles.* Observations have indicated that winds of gale force will cause free shingle tabs to flutter. In locations where such wind velocities can be anticipated it has been found desirable to fasten down the tabs either with cement, placed as shown in Fig. 3, or with special copper clips such as are commonly used at the exposed corner of rectangular shingles laid by the Dutch lap method. The cementing technique is considered more satisfactory as particularly heavy wind pressures can tear a clip loose from the underlying shingle to which it is attached. The cementing procedure has been proven quite satisfactory under winds of hurricane force, in excess of 85 mph, which frequently prove to be of demolition intensity. In

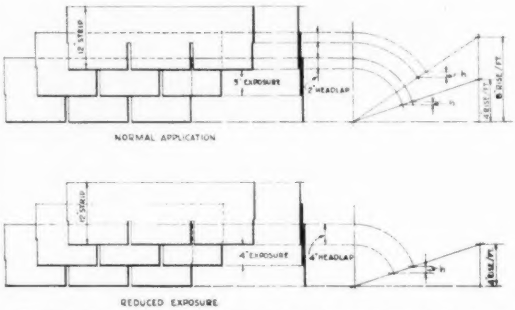


Fig. 2 Relation between roof pitch and weather resistance of shingles as reflected by variations in head lap

other words, buildings have been wrecked without shingles so applied being removed from the roof deck.

It is very important to distinguish between ordinary asphalt roof cement such as is used for patching, flashing and reinforcing, and quick-setting cement recommended for developing a strong bond. The latter is specially prepared with a volatile solvent to set up firmly — and quickly. It should not be used where it will be openly exposed to the weather after it has set. But it is essential where bond strength is called for. It is marketed under various trade names by different manufacturers for the specific purposes mentioned.

Wind Resistance Through Special Design. A comparatively recent demand has brought about the development of an interlocking shingle which is wind resistant in itself, and which provides the long-time protection of heavy double-coverage roofings. There are a number of variants of this type, each marketed under a different trade name by the manufacturer. Most, if not all, of these are heavy enough to be used on new construction and all can be used as reroofers.

Fig. 5 shows two typical designs. They are fairly large units which go on fast. They require but two nails per shingle which, together with the locking device, will hold them secure against winds of hurricane force.

Resulting roof patterns are of two general types. One group is rectilinear, all lines running either vertically or horizontally on the roof. Others have some diagonal pattern lines. They are both somewhat different than the usual square-tab shingle patterns which are held over from the early days of wood and slate shingles, but they are nonetheless pleasing on that account because they have very definite functional significance. These asphalt shingles automatically assume a style based upon function, a style peculiar to asphalt as a roofing material which will not be found duplicated in any other material. Proof of their effectiveness in resisting wind damage is shown in Fig. 6 which were taken after winds of hurricane velocity had severely damaged the structures on which they were used.

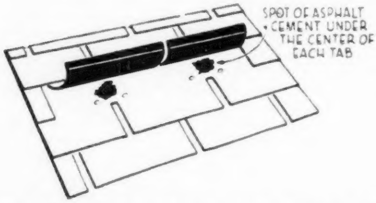


Fig. 3 Recommended preferred method of applying roll roofing. Nails concealed through the use of quick-setting cement

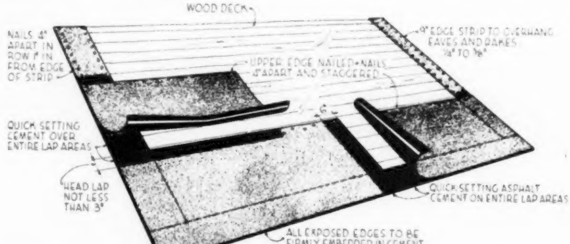


Fig. 4 A spot of quick-setting cement as large as a fifty-cent piece, placed under the center of each free tab, secures the shingle against high winds

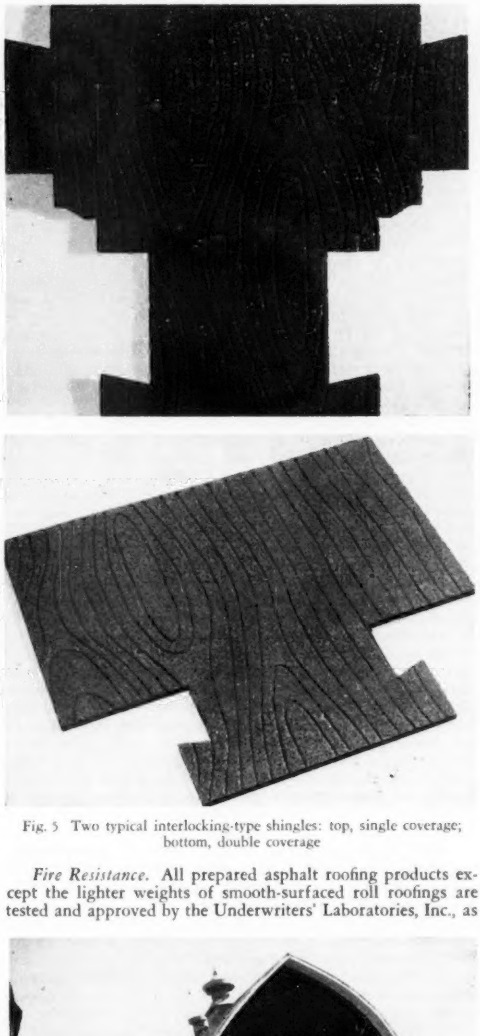


Fig. 5 Two typical interlocking-type shingles: top, single coverage; bottom, double coverage

Fire Resistance. All prepared asphalt roofing products except the lighter weights of smooth-surfaced roll roofings are tested and approved by the Underwriters' Laboratories, Inc., as

Fig. 6 This picture shows the effectiveness of the interlocking-type shingle, used on this barn, in resisting a wind of hurricane velocity

qualifying for their "C" label or classification. This identifies them as being "effective against light fire exposure," that is, they are "not readily flammable and do not readily carry or communicate fire; afford at least a slight degree of heat insulation to the roof deck; do not slip from position; possess no flying brand hazard, etc."

From a practical service standpoint this means that these roofings act to inhibit the spread of fire due to sparks and burning brands falling on the roof; and help to confine a fire that starts from some internal cause such as defective wiring, uncured hay, or oily rags. This is especially important on the farm where many times a fire in a relatively unimportant frame structure or a pile of brush has resulted in complete loss of the entire farmstead. The use of fire-resistant materials will mean the difference between partial and total loss, because the fire can be confined until firefighting equipment can be brought in from the nearest town.

An understanding of what the Underwriters' Laboratories, Inc., is will help to indicate the significance of its classification and point up what it means to the distributor and consumer of goods so labelled. Underwriters' Laboratories, Inc., was founded in 1894 under the sponsorship of the National Board of Fire Underwriters, as a non-profit organization without capital stock, to establish, maintain and operate laboratories for the examination and testing of devices, systems and materials. Not only will it test a material to determine its resistance to fire, but it will also set up minimum specifications to which the manufacturer must conform in order to remain eligible to use the label on his goods. The Laboratories maintain a check on a labelled product by factory inspections at regular intervals. Their engineers are afforded the privileges of the manufacturers' control laboratories and periodically visit, inspect, or analyze samples of the produce, thereafter reporting their findings to the Underwriters. If necessary, they will recommend to the manufacturer measures which in their judgment are required to maintain the standard of the product.

Under these circumstances it is obvious that when a package of roofing bears a certain label the material therein can be confidently expected to perform within the limits established by the definition of the classification.

Underfloor Heat Brooder

(Continued from page 608)

one thermostat, providing a brooding capacity of from 800 to 1000 chicks. These two units have about the same wattage as two conventional-type brooders but almost twice the chick capacity. It has been found that in no case should less than 32 w per sq ft be used. If less wattage is used, it will be found to be impossible to maintain an even temperature within the brooder. The thermostat is built in the floor and operates from floor temperature. The thermostat tube should always be placed about one-third the way in from the end of the brooder and between the second and third loop of cable.

It is desirable to have good drainage. We therefore recommend at least 6 in of cinders covering an area 11 ft long and 3½ ft wide. Over this is placed a vaporproof paper on which is placed at least 2½ in of expanded mica mixed in a ratio of 8 to 1 of cement. After this has hardened the cable is laid over an area 10 ft long and 2½ ft wide. In order to cover this area the cable loops will be approximately 2½ in apart. The finished floor of a standard mix concrete is now poured over the cable to a depth not greater than one inch after the electrical connection has been made to the sealed units of the cable. The brooder is now complete except for a very simple hover which is placed over the heated area only. This hover is merely an inverted box placed on legs with a curtain placed around the bottom edge. Two vent holes are placed in the top providing ventilation in the hover. Two attraction lights are placed under the hover for the birds.

The brooder is complete and ready for operation. Since these brooders have worked so well we are now running tests on a pig brooder of this same type and all indications point to a brooder as efficient and economical to operate as our chicken brooder.

Cotton Harvesting Mechanization in the Southeast

By F. A. Kummer
MEMBER ASAE

DURING the past two decades, a number of changes have occurred in the pattern of agricultural production in the Southeast. Among these have been: (1) a big reduction in total harvested row-crop acreage, particularly cotton, (2) a large increase in the acreage devoted to pastures and to grain and forage crops, and (3) large increases in the net production of beef, pork, milk, poultry, and eggs.

Accompanying the changes in the Southeast's production pattern, a number of other shifts and changes have occurred, all of which have affected farms and farmers, and which are important insofar as the future of the South's agriculture is concerned. Among these are (1) a decrease in the number of farms, (2) an increase in the average size of farms, and (3) a decrease in the percentage of tenancy, particularly share croppers.

One of the most significant shifts taking place in the Southeast's agricultural economy during recent years is the shift in cotton's relative position in the utilization of farm resources and as a farm-income producer.

In Alabama, the cotton acreage declined from more than 3 million acres annually during the 1920's' to about 1.5 million acres annually during the past decade — a decrease of 50 per cent. This decrease was offset by increase in yields per acre. Average yields increased from less than 150 to about 300 lb of lint cotton per acre — an increase of 100 per cent. The net result was that the state's annual production during the past decade was at about the same level as during the 1920's. These same trends are true for practically every other state of the Southeast.

Dean M. J. Funchess, director emeritus of the Alabama Agricultural Experiment Stations made the following statement a year ago at a meeting of leading agricultural workers in Oklahoma City: "It is absolutely necessary that all agricultural agencies that would serve the southern farmer have a clear picture of the place of cotton in the southern farm program. At the risk of offending those who consider cotton sentimentally, emotionally, or promotionally, let me say that the South can never be prosperous on cotton as long as it takes 200 hr and more of human labor to produce and pick a bale of the crop. From the beginning, it took about 70 hr of labor to pick a bale of cotton. It takes the same amount of labor today."

Southeastern farmers receive the lowest per capita farm income in the United States. Less than $500 per farm person as compared with $2,300 in Iowa and about $1,000 for the United States as a whole. In Alabama, we have approximately 10 million acres of agricultural land, yet all the cotton and peanuts which comprise the source of over one-half of the state's total farm income are produced on a little more than 2 million acres. How then may we help to increase our farm income? Certainly the availability of potential cropland is not an obstacle. The potentials are (1) farming for maximum production at the lowest possible cost, (2) increasing the natural fertility of the soils, (3) reclaiming potentially productive areas, and (4) producing commodities in greatest demand and particularly adapted to our climate.

There is no need to tell you, as agricultural engineers, that mechanization is the propelling force in such a projected program and that cotton is a southern crop. Cotton still brings in more income in a number of southeastern states than anything else produced on the farms, yet it usually occupies 20 per cent or less of the available cropland.

Farm mechanization has been making rapid strides in the Southeast. It should be no surprise to you that in Alabama alone the tractor population has risen in the last decade from less than 10,000 to almost 50,000 in 1951. The same phenomenal rise is true for all the other southeastern states. One major problem, however, is still with us, and that is the development and adaptation of machinery that will meet requirements of the area with respect to soil, topography, and crops. I should like at this point to give full and generous credit to the manufacturers and agricultural workers who have contributed much toward reducing labor requirements in cotton production in the past few years by their wholehearted cooperation in the regional cotton mechanization program. Speaking for the Southeast, however, one major bottleneck that still exists for the southeastern cotton farm is that of harvesting. In the words of Dean Funchess, "When each acre of land is made to produce as much as is economically feasible, and when each man day of labor is as efficient as possible through the use of adapted machines, southern farms will produce several times more than at present."

If we are to make progress along these lines, we will have to make every effort to adapt mechanical methods to the requirements of the area. We will have to take into consideration the size of our fields, which in general are much smaller than those of other cotton-growing areas. We will have to place more emphasis on machinery adapted to our rolling terrain so that it will operate efficiently on terraced land with contour rows.

For a number of years, the South Carolina Agricultural Experiment Station has taken the lead in development of mechanical cotton harvesting machinery for the Southeast under the regional cotton mechanization program. Because of the importance of this phase of agricultural engineering research in the Southeast, the responsibility has been divided this year for the first time between South Carolina and Alabama by mutual consent. South Carolina has assumed responsibility for development work with cotton pickers, while Alabama has been assigned responsibility for development work with cotton strippers of all types.

Speaking for the Southeast on cotton harvesting developments, I should like to quote the following summary of experimental results obtained at the South Carolina Agricultural Experiment Station, and furnished to me by George M. Nutt and his co-workers:

"The South Carolina station has tested both experimental and production models of stripper and spindle-type harvesters under conditions representative of the Southeast. The results are summarized as follows:

"1 Methods of seedbed preparation, planting, fertilization, and weed control must be adapted to mechanical harvesting.

"2 Uniform plant spacing is desirable.

"3 Weed control, whether mechanical or chemical, is of paramount importance.

"4 Complete defoliation is desirable.

"5 Tests indicate the need for varietal characteristics in cotton that will be best suited for mechanical harvesting.

"6 The spindle-type harvester proved adaptable to southeastern conditions, although terraces, contours, and the presence of rocks lowered the efficiency.

"7 The present type stripper is not adaptable to southeastern conditions.

"8 Two small experimental pickers were tested. The adaptability of these machines to condition in the Southeast was very encouraging."

In Alabama, during the last three years, preliminary experiments with cotton strippers were conducted at the Sand Mountain Substation near Crossville. It should be obvious to anyone here that our work with strippers was not predicated by any particular preference for this type of machine. Having witnessed with great interest the development of the cotton picker in the Delta under conditions prevailing there, we could imagine only a very limited applica- *(Continued on page 628)*

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Houston, Tex., June, 1951, as a contribution of the Power and Machinery Division.

The author: F. A. KUMMER, head, agricultural engineering department, Alabama Polytechnic Institute, Auburn.

The Drainage of Irrigated Lands

By C. R. Maierhofer
MEMBER ASAE

BASICALLY the major concept of drainage of irrigated lands is made up of plants, water, soils, and salts. Closely related to these considerations are the ever-present personal factors which lead farmers to overirrigate, engineers to build works which waste too much water upon the lands, soil scientists to classify lands as arable when they are not, and the drainage engineer to construct drainage works before he has sufficiently investigated the problem and its solution. Of the four principal factors leading to the drainage problem, the first three — plants, water, and soils — are common to any agricultural consideration. Only the fourth factor, salts, differentiates fundamentally between irrigated agriculture and any other kind. The occurrence, nature, effects, and removal of salts from irrigated lands is the challenge in drainage and the proper consideration of the problem requires the use of many tools such as hydraulics of surface and subsurface waters, soil physics and soil and water chemistry, the physiology of plants, and finally, one of the most important, the basic engineering knowledge necessary to conceive and construct efficient protective and relief works.

Salt accumulations in the soil come about principally in two ways: the salts are present due to natural soil manufacturing processes of mineral disintegration or through lake subsidation, or they are brought by waters of overflow or irrigation. The salts deposited through irrigation are of greatest importance to the drainage engineer in the West. As lands are irrigated, the applied water and precipitation above consumptive use leave the area as surface runoff and as percolation. Together with salt content of the irrigation water, percolation is the key to the drainage problem because only by this means may the salts be removed in solution. If percolation is unrestricted, the danger of salt accumulation is minimized. If percolation is too slow, adequate drainage may be impossible.

Quality of permissible water for irrigation is not a fixed value. Many variables determine the suitability of water of a known dissolved solid concentration. If soils are light and pervious, water of poorer quality can be more safely used than if the soils are heavier and of higher colloid content. On the other hand, water may be comparatively low in total solids, but still contain excessive amounts of ions injurious to plants, and therefore be unfit for use or usable only under excellent conditions of internal drainage.

All natural waters contain some solids in solution. The total amount and distribution of various ions in the solution is dependent upon the type of material the water has passed through or over from its precipitation to the point of irrigation diversion. In most western states, stream waters may vary in concentration from less than 100 ppm to over 1,500 ppm dissolved solids. In some instances, irrigation waters having concentrations as high as 5,000 ppm have been used. Expressed in a more tangible unit, salts may vary from about 1/10 ton per acre-foot to over 7 tons per acre-foot. When one considers that from 1 to 10 ft of water per season may be used for irrigation, the actual salt applications to the lands are of tremendous significance. During a period of only a few years, under conditions which may be considered average, startling quantities of salt are applied to irrigated lands.

Most soils have zones less permeable than the surface horizon at some easily determinable depth in the profile. These zones may occur as heavier soils, hardpans, cemented materials, or solid rock. They may be in the form of discontinuous lenses or as continuous strata. They may be several feet below the surface, or they may exist at greater depths. They may be underlain or overlain by previous materials such as sands or gravels, or they may become progressively more dense with depth. The location and study of these zones of limiting permeability and of the pervious overlying or underlying strata are of great importance. These strata are the principal causes of the drainage problems of irrigated lands or, conversely, the reason that only minor problems exist.

As the irrigation water with its salt load moves downward through the permeable surface soils, it is retarded when it reaches the less permeable horizon. If the permeability of the lower zones is less than is required to allow the applied water above field capacity to move downward in a required time, progressive saturation of the soils above the slowly permeable materials occurs and increases in elevation with each irrigation. If the slowly permeable materials are deep, no serious damage may be noted for long periods. If, on the other hand, the tight zone is near the surface, serious drainage difficulties occur during the first few seasons of irrigation. These drainage troubles come about in two ways or in combination. Usually the first to be noticed is waterlogging of the root zone, literally drowning the plant. This may then be followed by the other but no less damaging situation manifested by increasingly high salt concentrations at the surface and in the root zone. This latter occurrence is due to capillarity.

As accumulating ground water approaches the surface, capillary lift, acting through the interstices of the soil, forces the moisture upward where rapid evaporation soon concentrates the soluble salts to the extent that plant growth is retarded. After several seasons under typical western conditions of hot sun, low humidity, and low precipitation, salt concentrations become so great that effective germination of seeds is not possible and crop production rapidly declines.

The relief measure to be applied to accumulation of salt and excessively high ground water is drainage. There is no short cut to lowering the water table, removing the salts, and preventing additional salt accretions. Ground water must be lowered to the extent that capillary rise will be maintained below the depth at which evaporation can occur, thus reducing salt accumulations. In some instances it is neither possible nor economically feasible to do this due to the confining zone being at a lesser distance from the surface than the thickness of the capillary fringe. In some such cases increased lateral ground-water movement immediately above the confining material may be established. This provides sufficient rate of ground-water removal to an artificial outlet such as a drain, so that it will not accumulate.

Drains are of five types and may be used singly or in combination, depending on local conditions and requirements. They are surface drains, deep open drains, closed or tile drains, inverted wells, and pumped wells. All are self-descriptive except possibly the well types. Inverted wells may be used for drainage purposes where permeable unsaturated beds underlie the area requiring drainage. Drainage water may be admitted at or near the top of the well and be discharged into the permeable bed at lower levels in the well. The pumped well may offer the most efficient solution to drainage problems under certain conditions. Drainage by pumping is feasible only in localities having extensive underlying aquifers of good depth and with large areas of influence under nominal drawdown. Pumped-well drainage may prove especially effective in areas where the underlying aquifer is too deep to be reached directly by gravity drains or relief wells and where a deep drain is ineffective because of low permeability of the overlying soil.

All soils have some internal drainage capacity. The internal drainage capacity of a soil is essentially the rate of movement of water through that soil. This rate is largely controlled by two factors — the capacity of the soil to transmit water vertically, or downward percolation, and its capacity

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Washington, D.C., June, 1950, as a contribution of the Soil and Water Division.

The author: C. R. MAIERHOFER, head, drainage engineering div., Bureau of Reclamation, U.S. Department of the Interior, Denver, Colo.

to transmit water laterally. In each instance capillarity, soil density, soil texture, soil structure, arrangement of pore space, and chemical characteristics of the soil and water are factors in the rate of movement. The total rate of movement, which is the significant consideration, is the component of all factors in the zone to be drained and the practical vertical depth within which the drainage may be accomplished.

The first recognition of internal drainage ability of a soil is made by the land classifier or soil scientist when the lands are initially appraised. Specifically, the land classifier determines whether lands to which it is possible to divert water are suited to sustained irrigation agriculture. The relatively stable factors of primary importance in making these determinations of suitability are soil, topography, and drainage.

Most soils have developed through natural processes sufficient internal drainage to accommodate precipitation of the area; this one of nature's eternal tendencies to balance its own forces, thereby maintaining the equilibrium in which we exist. When we then artificially apply much more water to an area than nature intended, this balance is upset. In order to return the component forces to equilibrium, we must artificially reinforce that which we have overloaded. In the conversion of arid lands to irrigated lands this means subsurface drainage. There is little that can be done to increase deep percolation, but by constructing drains at suitable locations and depths the rate of lateral movement of ground water may be increased. This is the major objective of subsurface drainage.

AMOUNT OF ARTIFICIAL DRAINAGE IS DETERMINED

As the land classifier takes the first look at these things he attempts to appraise the amount of internal drainage which exists. The drainage engineer then takes a deeper look and attempts to determine, in cooperation with the classifier, how much artificial drainage will be required after irrigation and how and at what cost it may be provided. This involves a study of permeable strata which may exist within a depth to which drains may be economically constructed. It is in these zones that drains must be placed to provide accelerated lateral movement for percolating water from above. If highly permeable material exists above the confining strata within a depth of practical construction, the required drainage will be quite effective and may be installed at wide spacing and at low cost. Such conditions exist in limited locations in the western states but are more usually found in the Northwest and Southwest. In other instances, the permeable material may exist just below the zone of limited permeability. If the material is within practical depth, say, 10 to 12 ft, the heavy zone may be penetrated by the drain and increased outlet for lateral movement provided, but at greater cost due to closer required spacing. The most costly and difficult drainage to accomplish is generally in soils having profiles progressively less permeable with depth. In such soils there is no zone within which increased lateral movement of ground water may be established. These conditions are usually typified by soils of recent alluvial or glacial deposition. They also occur in most of the West, but principally in the northeastern quadrant of the western states.

The importance of studying the subsurface characteristics of lands before they are developed for irrigation and before any works are constructed cannot be overemphasized. Only in this way can the ultimate costs of drainage be realistically recognized. Deep drains, with their appurtenant structures, generally cost from $10,000 to $20,000 or more per mile at current prices. This may amount to $25 to several hundred dollars per acre for drainage construction alone. Therefore, early investigation and recognition of drainage requirements are necessary in project feasibility determinations, as well as being a source of design data for protective works to be later constructed. The economic phase of a drainage investigation is often overlooked by the scientist, and there are embarrassing instances where apparently sound projects have failed because the ultimate costs or conditions limiting the possibilities of drainage were not initially considered.

Drainage as a science is comparatively young. Little information lends itself to realistic computation of drainage requirements, and few reliable technical procedures applicable to a wide variety of conditions are known. We must admit this and patiently await the proving of new ideas of drain depth and spacing determinations. These will come about, but only through research and long application of the fiindings to field conditions. Soil is a highly heterogeneous medium and the conclusions reached in one area may be entirely misleading when applied to the adjacent; therefore we must be cautious in basing large expenditures on unestablished performance. We must slowly feel our way through the problems. In this connection, I believe that the greatest recent advances in drainage are the growing realization that the problem must be investigated before it exists, and the improved techniques of investigation. We have a good start in developing the processes of investigating the drainage problem; we have much farther yet to go.

This paper will be criticized for not having dwelled more on the technical phases of drainage and the technical treatment of special problems. Each in itself would have taken more than the allotted time. Most of the discussion was concerned with the basic principles of drainage thinking rather than the existing, neglected problem. This was purposely an attempt to pass on to you a strong personal conviction based on nip-it-in-the-bud philosophy. We should not let ourselves be found in the position of having neglected to consider the drainage requirement long before it is before us in the form of crop damage and soil deterioration. We have learned the hard way through the years that, to get the most out of the farmer's drainage dollar, we must anticipate and observe and protect, rather than procrastinate until the damaging symptoms of inadequate drainage have eaten into productivity. If we wait too long, the problem becomes one of relief rather than protection, and the gross costs of investigations and construction for relief are much greater.

THE MOST PRESSING REQUIREMENTS RELATED TO DRAINAGE

In conclusion, I present my own opinion of the most pressing requirements for better understanding, administration, and execution of drainage needs. In relation to investigations, we need more reliable and cheaper methods of determining true soil permeabilities leading to more accurate prediction of drain-spacing requirements.

An exploration of methods of financing drainage work should be conducted. At present costs, few farmers can afford to build the works required to keep irrigated lands as good as they were before irrigation. This is our responsibility to future generations and to the continuing conservation of the national resources. Perhaps protection of lands against deterioration due to waterlogging and excessive salt accumulations is a national responsibility to be shared by all citizens. This leads to the philosophy that drainage costs should be non-reimbursable as are flood control, forest protection, and fish and wildlife propagation. I merely mention this as one possibility.

A prime necessity is training by our engineering and agricultural schools of students in full curriculums of courses pertinent to drainage by qualified, experienced instructors. To my knowledge, drainage courses now offered are minor in number and largely inadequate in scope. The organization with which I am connected frequently requires qualified drainage engineers capable of handling advanced professional assignments, but we have little success in recruiting them or students sufficiently well prepared to be trained for these positions.

And, finally, agriculturists, engineers, and farmers engaged in irrigation must be taught the necessity for and recognition of early symptoms and causes of drainage problems, at least to the extent that they know when competent specialized counsel is required. Improper advice, overirrigation, poor surface drainage, and excessive canal and lateral losses have resulted in wasteful expenditures for drainage works throughout the West. These things can be remedied only by a closer relation between the technical agriculturist, the engineer, and the farmer.

A Graphic Method of Solving Sprinkler Irrigation Application Problems

By James E. Garton
ASSOCIATE MEMBER ASAE

IN THE design of sprinkler irrigation systems an easy means of relating plot size, sprinkler discharge, and operating time is needed. The accompanying nomograph relates these variables involved in sprinkler design.

The plot size is the distance between the nozzles on the lateral multiplied by the distance the laterals are moved at each setting. The primary factors affecting sprinkler spacings are the wetted diameter of the sprinkler-discharge pattern and wind conditions.

For a given size of plot the discharge of the nozzle to be used will be determined by an application rate somewhere between the minimum and maximum rates of application recommended for that soil.

The operating time required depends on the application rate and the depth of water to be applied. The depth to be applied will depend on soil and crop conditions and the water-application efficiency.

In the example shown the designer has selected a 40-ft nozzle spacing on the lateral and a 60-ft spacing of laterals. These are selected on the basis of the wetted diameter of the nozzles considered and wind conditions in that locality.

An application rate of from 0.50 to 0.75 iph is satisfactory for the soils of the design area. This range of application rates would require a discharge of from about 12.5 to 19 gpm. A nozzle having a discharge of 14 gpm at the desired operating pressure is selected. This discharge gives an application rate of about 0.56 iph.

The designer decides on an irrigation application of 4 in and finds that this application will require 7.2 hr of operation.

This nomograph is not intended as a replacement for good design procedure, but it is a useful aid to the application of good design procedure to sprinkler irrigation design problems.

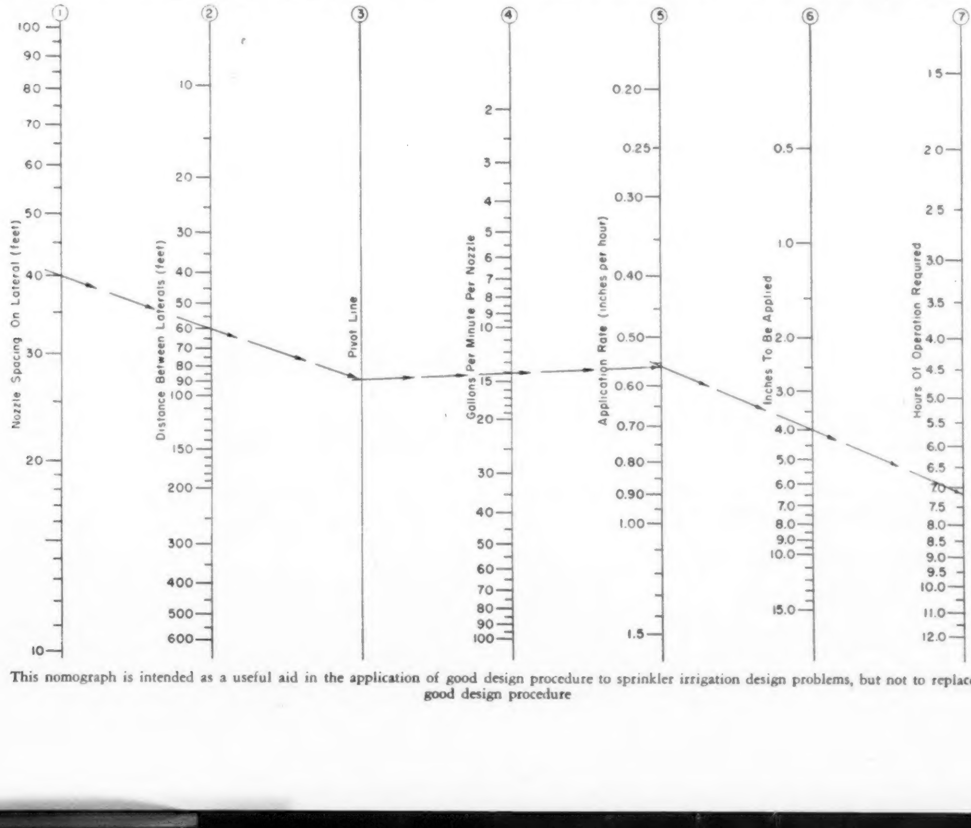
This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The author: JAMES E. GARTON, assistant professor of agricultural engineering, Oklahoma A. & M. College, Stillwater.

Basic Research a Foundation for Invention

AMERICA'S present industrial supremacy may be traced largely to the fact that this country has had a type of government which has encouraged its people to invest, to translate their inventions into marketable products, and to manufacture such products in quantity and at a cost to stimulate and satisfy public demand. The welfare of our country in the future, even more so than in the past, will depend upon its scientific and technological developments, and these, in turn, will require people who have ability to create basic scientific knowledge.

In the past, our inventors were fortunate to be able to draw upon the basic science findings of other countries, mainly Europe. Unfortunately, two world wars have greatly depleted the human and material resources of other lands, so that for many years in the future the U.S.A. has the responsibility for building up a stock pile of basic scientific knowledge. Our great asset as a nation has been our ability to convert scientific knowledge in practical utility. Basic research, on a scale commensurate with the dominant position of the U.S.A. in applied research and invention, is essential to protect the industrial and technological competence of our people. —Dean A. A. Potter in *The Journal of Engineering Education*



This nomograph is intended as a useful aid in the application of good design procedure to sprinkler irrigation design problems, but not to replace good design procedure

RESEARCH NOTES

ASAE members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

USDA Agricultural Engineering Research

RESEARCH in four major branches of agricultural engineering — structures, machinery, processing, and electrification — are centered in four distinct divisions in the U.S. Department of Agriculture, and have been administered by A. W. Turner (past-president ASAE) since 1944, and in that time has done much to increase the scope and importance of engineering research of the USDA. Administrative headquarters of the Divisions of Agricultural Engineering are at the USDA Agricultural Research Center, Beltsville, Md. However, the bulk of the research is actually conducted in the field, often in cooperation with the state agricultural experiment stations. Because agricultural engineering research touches almost every field of the science of agriculture, it has proved best to place USDA research agricultural engineers at locations where the need for research is felt.

The Division of Farm Buildings and Rural Housing is the USDA unit responsible for agricultural engineering research in this field. Head of the Division is Wallace Ashby. His organization, made up of 39 members, is currently engaged in research concerned with beef and dairy cattle, hog, and poultry shelters and housing. Farm homes are also undergoing intensive study. This Division is also largely responsible for the mass of research that has been conducted successfully in grain drying and storage, a farm practice becoming more in evidence each year. Engineers in the Division are also engaged in research with new and improved farm building materials, and with potato and fruit storages.

The Division of Farm Machinery carries on all engineering machinery research for the Department, and headed up by R. B. Gray. The Division is engaged in machinery research concerned with the production of almost all crops. Currently receiving attention is machinery for the production of cotton, potatoes, legume seeds, sugar cane, tung, peanuts, and the defense-important crops such as guayule and castor beans. Also under intensive study are fertilizer placement machinery, weed control and pesticide application machinery, and tillage implements including the tractor.

The Division of Farm Electrification, under the leadership of Dr. T. E. Hienton, carries forward agricultural engineering research in this broad field. Current research of this Division embraces barn drying of forage crops, heat pump studies for farm home air conditioning, black light insect trapping in corn, tobacco, cotton, and sugar cane, ultrasonic effects on seed viability and germination, radio-frequency drying of farm crops, farm refrigeration, tobacco curing, the effect of bactericidal lamps on poultry, electric feed mixing and grinding, beehive heating, and a study of standby farm electric plants.

The Division of Mechanical Processing of Farm Products is the agricultural engineering research unit serving USDA in this field. Geo. R. Boyd heads this Division, which is engaged in outstanding research work in cotton ginning, fiber flax processing, feed milling, and other rural industries, and quality improvement of many crops. Current research with special application to the defense needs of this country is emphasized in this Division's work with hard fibers, attempting to find a suitable replacement for Manila hemp, and other fibers which are often hard to get in times of stress.

Agricultural engineers who find themselves in the vicinity of Washington, D.C., with time on their hands, should utilize it by visiting the U.S. Department of Agriculture's Agricultural Research Center at Beltsville, Md. This 12,000-acre farm, only a few miles north of Washington on the Baltimore Pike, headquarters the Divisions of Agricultural Engineering of the Department. This unit is the engineering research arm of USDA.

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USDA Notes on Potato Harvester and Lightweight Concrete, Research and Poultry Dressing Plants

Potato Harvester Research. The greatest single machinery need of potato growers today, from the standpoint of cost reduction, is a harvester that will handle the tubers mechanically from the ground to field container. The machine most sought after is one that will dig the potatoes, lift them from the ground, separate them from loose dirt, clods, stones, weeds, and the vines, and place them in special self-unloading trucks or in handling containers, all with a minimum of bruising and skinning.

Another current trend is toward the design of a windrow harvester that will follow the digger and pick up the potatoes from a windrow. Ultimately, says A. H. Glaves, USDA engineer, these two lines of research may result in a harvester that will serve as a two-row windrow pick-up machine, or be convertible to a one-row direct digger-harvester.

Vine elimination is one of the problems that must be ironed out by research engineers before a satisfactory harvester can be developed. Current research is attempting to develop a vine puller that will pull the vines prior to harvest to hasten maturity of the potatoes and cut the vines in short lengths to reduce the vine nuisance at harvest time. Some recent experimental work has indicated that pulling the vines is the most effective and quick-acting method for hastening maturity. If such a machine can be perfected, Glaves says, it would eliminate the need of a deviner in the final harvester.

Separation of clods, stones, and dirt from potatoes, is a harvester function that has been receiving attention during the past few years. USDA research has developed an experimental separator that worked well in trials in the potato fields of the Red River Valley last summer. It operates automatically under normal field conditions, or can be supplemented with hand labor under severe stone or clod conditions. The separator uses a multiple V-belt unit with interceptor wheels that also act as belt spacers to maintain the proper distance between the long V belts so that they cannot spread and let marketable-size potatoes fall through. The separator's possibilities for use under regular farm conditions have only been partially explored, Glaves says, but its performance has appeared promising enough to warrant continued study.

• • •

Lightweight Concrete Research. Although no lightweight concrete can yet be recommended for farm use, USDA structural engineers are currently engaged in two promising research approaches looking toward such a development. Lightness and better insulation qualities go hand-in-hand in most structural materials like concrete.

In a research project in cooperation with Michigan State College, the engineers are substituting corncob pellets, of about $\frac{3}{8}$-in diameter, for the coarse aggregate of concrete. In another project in cooperation with the National Bureau of Standards, they are substituting air for the sand in concrete. In research so far, air spaces in the concrete have come from the bubbles produced by the use of a commercial detergent.

The engineers' research indicates that corncob concrete can be used successfully for solid concrete units. A wall and a floor slab of corncob concrete were exposed to weathering for 15 months, including two winters, with no apparent bad effect. However, cored blocks incorporating the cob pellets proved hard to make and hard to use.

From the standpoint of safe building strength, the volume of cob pellets could not be more than three times the volume of cement used. The engineers also found it necessary to soak the cob pellets in water for five to six hours before using them in a concrete mix. Otherwise the job pieces absorb moisture from the mix and cause the concrete to rupture while setting.

The success of air-gravel concrete, according to results of the tests, depends primarily on the development of a method of controlling the air content in the mixture that is simple enough to use in normal construction. Laboratory mixed batches of air-gravel concrete proved strong enough for floors or lightly loaded walls in farm building when 24 or 25 per cent air was incorporated with as little as $3\frac{1}{4}$ bags of cement per cubic yard of concrete. As normally mixed for comparable farm uses, a cubic yard of concrete requires 4 to $4\frac{1}{2}$ bags of cement. The investigators incorporated 45 per cent air in one satisfactory sample, but were forced to use excessive amounts of cement to make the concrete strong enough.

The air gravel concrete averaged 30 lb less in weight per cubic foot and provided about twice the insulation of ordinary concrete. The air-gravel concrete also absorbed less moisture and had less tendency to soak up water through capillary action than did ordinary concrete. Freezing and thawing tests that brought ordinary concrete almost to the point of failure, actually improved the structure of the air-gravel concrete, including excellent resistance to weathering.

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Small Poultry-Dressing Plants. Plans for efficient, small poultry-dressing plants, of interest to poultry farmers, commercial poultry producers, poultry and egg dealers, and cooperatives have been developed by a USDA engineer after a study of 48 such plants in 10 northeastern states. The plans appear in FCA Miscellaneous Report 147, "Plans and Operations of Farm and Small Commercial Poultry Dressing Plants."

In small plants, employing from two to nine workers, each employee can work at top production capacity with a minimum of walking or wasted motion. Compared with larger plants, the small farm or community plants have a greater labor output per worker, require smaller investments, have lower labor costs, and less personnel turnover.

One of the dressing plants illustrated in this report is designed as a family or farm unit employing two to five workers. Two other plans are for small commercial plants, employing from five to nine workers; one plan including a cold storage room and a salesroom.

Single copies of Misc. Report 147 can be got free by ordering from the Director of Information and Extension, Farm Credit Administration, U.S. Department of Agriculture, Washington 25, D.C.

NEWS SECTION

ASAE Winter Meeting Program

THE usual Winter Meeting of the American Society of Agricultural Engineers will be held at the Stevens Hotel, Chicago, December 17, 18, and 19. The program for the meeting is being sponsored by the Society's four technical divisions — Power and Machinery, Rural Electric, Farm Structures, and Soil and Water. Copies of the printed program and other information about the meeting are being mailed to all ASAE members, and non-members of the Society may obtain full information about the meeting and program on request to the Society headquarters office at St. Joseph, Michigan. The principal features of the program are presented here:

POWER AND MACHINERY PROGRAM

The power and machinery program has been arranged under the direction of Geo. B. Hill of the New Idea Farm Equipment Co., chairman of the Power and Machinery Division. The first day's program (December 17) opens with a paper on the design and application of universal joints for farm machinery by Fred M. Potgieter, Mechanics Universal Joint Division of Borg Warner Corp. This will be followed by a discussion of loads imposed on power take-off shafts by farm implements by Merlin Hansen, John Deere Waterloo Tractor Works and a progress report of the industry committee that has been investigating power take-off drives.

The program for the afternoon of the same day includes three papers, one on steel chain applications in farm machinery by Bert L. Pearce, Link-Belt Co., another on the hydraulic capacity requirements for control of farm implements by W. H. Worthington, John Deere Waterloo Tractor Works, and the third on electrostatic precipitation of dust materials by H. D. Bowen and Peter Hebblethwaite of Michigan State College.

An evening program devoted to illustrated talks on mechanization of foreign agriculture has been scheduled for December 17, the first of which will be on American farm machines as adapted to Guatemala agriculture by E. L. Barger, Harry Ferguson, Inc., the second will be on farm machine requirements of Turkish agriculture by H. P. Smith, A. & M. College of Texas, and the third on native farm implements in use by farmers of Japan by Roy Bainer, University of California.

The program for the second day, December 18, will open with a progress report on the design and performance of hay rakes by G. W. Giles and C. A. Routh, North Carolina State College. This will be followed by C. Ray Thompson, Western Regional Research Laboratory, USDA, on methods for stabilizing carotene in alfalfa. The last number on the program of this session will be a report on field performance of side-delivery rakes by Roy Bainer and L. G. Jones, University of California.

The afternoon program of the same day will be devoted to a symposium on recent research results in field drying of corn and small grains as conducted by agricultural engineers in four state agricultural experiment stations of the Middle West: L. W. Hurlbut, Nebraska; J. H. Ramser, Illinois; D. L. Woolsoncroft, Iowa; and G. H. Foster, W. F. Rissmiller, D. E. Burrough, and R. P. Harbage, Indiana (Purdue).

The forenoon program of the third day, December 19, will feature reports of a regional study of corn-planter fertilizer depositors for high-speed operation conducted during the 1951 season. The program will open with a statement on the interest of the farm equipment industry in this regional study by R. M. Merrill, Deere & Co., followed by an introductory statement by G. A. Cumings, agricultural engineer, USDA, who took a major part in the planning and carrying out of the study. This will be followed by reports of the field studies conducted in nine states — Michigan, New York, Illinois, Missouri, Iowa, Minnesota, South Dakota, Nebraska, and Kansas. A summary of the regional study and special attention to some of the machinery problems encountered will be presented by C. E. Guelle, International Harvester Co. The program for this session will close with a paper on pasture fertilization by W. R. Thompson, Mississippi State College.

The program for the afternoon of December 19 includes two papers, one on essentials of safety and corn picker operation by C. J. Scranton, Allis-Chalmers Mfg. Co., and the other on the technique of measuring torque of rotating shafts under field operating conditions by D. E. Burrough, Purdue University.

RURAL ELECTRIC PROGRAM

The rural electric program for the meeting has been arranged under the direction of the chairman of the Rural Electric Division, H. S. Hinrichs, Kansas Power and Light Co. The program for the forenoon of December 17 is being sponsored by the ASAE Committee on Feed Handling and will be devoted to the general subject of what is new in the handling and processing of farm feeds. It will open with a brief report of the Committee by its chairman, Howard C. Rutt, Public Service Co. of Northern Illinois. Paul L. Lyman of Kansas State College will discuss work he has done on the use of the roller crusher as an automatic feed for grinding ear corn with a small hammer mill, and W. G. Buchinger, The Detroit Edison Co., will discuss a new type of ear corn grinder. Two papers will be given on the development of automatic units for handling and processing ground feeds on the farm, one by F. W. Duffee and L. A. Brooks of the University of Wisconsin and the other by M. W. Forth of the University of Illinois and L. S. Foote of the U.S. Department of Agriculture. Then will follow a 40-minute general discussion on farm feed handling, conducted by the Committee on Feed Handling, following which a summary of recent developments in automatic feed handling, with recommendations, will be given by E. W. Lehmann, University of Illinois.

The afternoon program of the same day will feature new developments in rural electric equipment, including barn cleaners by H. S. Brenbeck, United Cooperatives, Inc.; crop drying equipment by Ray Arndt, Avco Mfg. Co., and Nolan Mitchell, Aerovent Fan Co.; infrared brooding by Lorin J. Badskey, LML Eng. and Mfg. Co., and automatic egg gathering by J. H. Bodwell, New Hampshire Gas & Electric Co. Paul A. Young, National Dairy Products Co., will discuss one farmer's experience in the use of electrical equipment.

A joint Rural Electric and Farm Structures program is scheduled for the forenoon of December 18, and the evening of December 18 is to be devoted to an open forum on rural electric equipment items available or needed with D. E. Washburn, United Cooperatives, Inc., presiding.

The forenoon program of December 19 will feature a symposium on electric brooding of chicks and pigs. It will open with a discussion of the physiological aspects of chick brooding by Dr. James H. Bywaters, Virginia Agricultural Experiment Station, followed by a talk on the effects of radiation of various wave lengths on living tissue by Dr. R. D. Spence, Michigan State College. Resumes of research on electric chick brooding will be presented by June Roberts, State College of Washington; C. N. Turner, Cornell University; L. A. Brooks, University of Wisconsin; and V. H. Baker, Virginia Agricultural Experiment Station. W. D. Hemker, Westinghouse Electric Corp., will discuss a new control for infrared lamp brooding for chicks, and the fundamentals of infrared brooding of pigs will be discussed by John G. Taylor, U.S. Department of Agriculture.

The program for the afternoon of the same day will feature the application of the heat pump to farm production processes and will open with a paper on heating water with the heat pump by Andrew Hustrulid and H. A. Cloud of the University of Minnesota and discussion by L. F. Charity, Virginia Polytechnic Institute. William G. Buchinger, The Detroit Edison Co., will talk on heating the milk house from the milk cooler, and Ralph I. Lipper, Kansas State College, will report on his work on the use of the heat pump for heating Kansas homes.

FARM STRUCTURES PROGRAM

The farm structures program is being arranged under the supervision of the Farm Structures Division Chairman, C. K. Otis, University of Minnesota. The opening session on the forenoon of December 17 will include a discussion of the results of time-and-motion studies on dairy farms made by Thayer Cleaver, U.S. Department of Agriculture, which will be followed by a report of results on milking parlor research by S. A. Witzel, University of Wisconsin. The closing number on the program, on milking parlor construction for good sanitation, will be presented by H. B. Bradshaw of the DeLaval Separator Co.

The afternoon program of the same day will feature the subject of standardization of farm buildings. A paper on the need for standardization will be presented by E. G. Molander, U.S. Department of Agriculture, and R. R. Britton, Facilities and *(Continued on page 620)*

ASAE Meetings Calendar

November 16—OKLAHOMA SECTION, Student Union Bldg., Oklahoma A. & M. College, Stillwater

December 7 and 8—ALABAMA SECTION, Gadsden, Alabama.

December 17-19—WINTER MEETING, The Stevens, Chicago, Ill.

January 31—PACIFIC COAST SECTION, Davis, Calif.

February 4-6—SOUTHEAST SECTION, Atlanta Biltmore Hotel, Atlanta, Ga.

June 16-18—ANNUAL MEETING, Hotel Muehlebach, Kansas City, Mo.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to A.S.A.E., St. Joseph, Michigan

NEWS SECTION *(Continued from page 618)*

Construction Bureau, National Production Authority, will discuss the possibilities for effecting economies through dimensional coordination and methods of construction.

Representatives of industry will discuss possibilities for standardization of farm buildings as represented by various classes of building products including metal products by J. Edmund Bowen, Stran-Steel Div., Great Lakes Steel Corp.; wood products by Ortie LaVoy, Weyerhaeuser Sales Co.; masonry products by M. L. Burgener, Portland Cement Assn., and glass products by W. Everett Eakin, Libbey-Owens-Ford Glass Co.

A joint farm structures and rural electric program is scheduled for the forenoon of December 18 featuring the results of farm ventilation research. The opening subject to have attention is heat and moisture production of farm animals, and under this topic H. J. Thompson, U.S. Department of Agriculture, and R. E. Stewart, University of Missouri, will discuss results of research with cattle; H. L. Garver, J. R. Vincent, and Hajime Ota, U.S. Department of Agriculture, will discuss the results of research of poultry, and C. F. Kelly and H. Heitman, Jr., University of California, and T. E. Bond, U.S. Department of Agriculture, will discuss the results of research with swine. Richard Boonstra, Public Service Co. of Northern Illinois, will discuss the results of studies of poultry and dairy barn ventilation which have been conducted under his supervision. The final number on this program will be presented by W. J. Promersberger, North Dakota Agricultural College, and will report on results of his work on forced versus natural draft ventilation in poultry houses.

The afternoon program of the same day will open with a discussion on farm house plans that meet varied needs by Murlin R. Hodgell, University of Illinois. George W. A. Mahoney, Oklahoma A. & M. College, will talk on farm building plan services with sales appeal, and Everett D. Markwardt, Cornell University, and M. J. LaRock and Dick J. Stith, University of Wisconsin, will discuss the work of the farm structures extension field engineer.

SOIL AND WATER PROGRAM

The soil and water program has been planned under the general direction of the chairman of the Soil and Water Division, R. R. Poynor, International Harvester Co. The opening session on the forenoon of December 17 will feature the general subject of splash or raindrop erosion of soil. George R. Free, U.S. Soil Conservation Service, will discuss soil movement by raindrops, and will be followed by P. O. Ekern, University of Wisconsin, who will present a laboratory analysis of splash erosion. The relation of soil splash to soil deterioration, erosion losses, and conservation practices will be discussed by Forrest G. Bell of the Soil Conservation Service. The concluding number on the program of this session will deal with erosion control in engineering works to be presented by L. J. Goodman, Ohio State University.

The afternoon program of the same day will deal with the general subject of flood control. The first paper by Leo S. Terbush, U.S. Soil Conservation Service, will discuss the small-dam program for the control of floods, and this will be followed by a paper on performance of field structures under extreme flood flow by Frank C. Mohler, also of the SCS. The effects of conservation practices on watershed yields will be presented by Neal E. Minshall of SCS, and Lloyd L. Harrold, also of SCS, will discuss land management by more use of soil porosity for water conservation.

The forenoon program of December 18 will feature the general subject of drainage of agricultural lands and will open with a discussion by L. A. Jones, U.S. Soil Conservation Service, of the effects of drainage on agricultural production. This will be followed by a talk by Keith H. Beauchamp, also of SCS, on surface drainage of tight soils in the midwest states. B. F. Muirheid, University of Illinois, will discuss results of some of his tests on draintile in Illinois. D. G. Miller, University of Minnesota, will report briefly on tile drainage in Ireland as observed during a visit to that country this past summer, and Don Kirkham, Iowa State College, will take on some of his findings in a survey of the reclamation work on inundated lands in the Netherlands he conducted this year.

The program for the afternoon of the same day will feature the general subject of sprinkler irrigation. Hydraulic characteristics of gated pipe and Perf-O-Rain types E and F sprinkler pipe will be discussed by C. N. Johnston and Moshe Besubov, University of California, and Allan W. McCulloch, Irrigation Equipment Co., will discuss sprinkler irrigation design problems. A progress report on sprinkler irrigation of corn and pasture crops in South Carolina will be the subject of a talk by W. P. Law of the Clemson Agricultural College. Water-application efficiencies in irrigation in relation to the time rates of water application will be discussed by W. H. M. Morris of Cambridge, England, who is presently a research fellow at the Utah Engineering Experiment Station.

A conference on depth and spacing of tile drains, sponsored by the Society's subcommittee dealing with this subject, under the chairmanship of R. K. Frevert, Iowa State College, will be held on the forenoon of December 19 and will open with a paper on the depth and spacing of drain laterals as computed from core sample permeability measurements by Phelps Walker of the U.S. Soil Conservation Service. A summary of tile depth and spacing research will be presented by members of the Committee from the University of Minnesota, University of Illinois, Iowa State College, Purdue University, and the U.S. Soil Conservation Service. This program will be followed, in the afternoon, by a round-table discussion of research techniques and problems.

Another conference, on sprinkler irrigation, is being arranged for the forenoon of December 19 by the Subcommittee on Sprinkler Irrigation Research under the direction of its chairman, E. H. Kidder, Michigan State College. The opening subject on this program is evapotranspiration estimates as criteria for determining when to irrigate by Dr. C. H. van Bavel and T. V. Wilson, North Carolina State College. This will be followed by a discussion of labor requirements for sprinkler irrigation of corn by M. W. Bittinger and R. K. Frevert, Iowa State College. The relationship between nozzle pressure and drop size and between drop size and soil aggregate breakdown will be discussed by Gilbert Levine, Cornell University. W. L. Jacobson, Dominion Experimental Station, Lethbridge, Alta., will give a resume of his research work in sprinkler irrigation. Aldert Molenaar, State College of Washington, will report on his study of the factors influencing uniformity of water distribution from rotating sprinklers.

Farm Structures Research Panel in Chicago

THE Better Farm Buildings Association of which the American Society of Agricultural Engineers is a member organization, will sponsor a dinner and panel discussion on farm building research at the Stevens Hotel, Monday evening, December 17, in conjunction with the ASAE winter meeting.

Purpose of the program according to W. Everett Eakin, BFBA president, is to bring together representatives of the dairy, poultry and swine industries with agricultural engineers, farm building material manufacturers and the farm press for a discussion of farm building problems.

"It is hoped by this discussion," Eakin said, "to put more emphasis on the need for greater research in farm building design for more efficient material handling, better shelter for livestock and poultry and as a means af labor saving."

Dinner reservations should be made by December 10 through a member of the Better Farm Buildings Association or directly with the president of the BFBA at 1211 Nicholas Building, Toledo 3, Ohio.

Leaders in the dairy, poultry and animal husbandry fields have been invited to participate in the panel discussion along with agricultural engineers.

Three-Day Farm Structures Short Course

A THREE-DAY farm structures school (short course), to be held January 8 to 11, 1952, is being offered by the Department of Agricultural Engineering, University of Illinois, Urbana. While intended primarily for building materials dealers and builders, this short course will be of interest also to field men and manufacturer's representatives who desire up-to-date information on developments in farm structures.

Persons interested in attending this school should communicate direct with Deane G. Carter, acting head, agricultural engineering dept., College of Agriculture, Urbana, Ill.

Washington Section Has Interesting Program

MEMBERS and guests of the Washington (D.C.) Section of the American Society of Agricultural Engineers, attending the October 12 luncheon meeting, got an inside view of the problems of allocating critical materials for agricultural purposes. John Stambaugh of the Office of the Secretary of Agriculture said that it is imperative that every one understands that our agricultural industry is one that produces food —a basic item in the defense effort. Many of the personnel of the National Production Authority and the Defense Production Authority are unacquainted with the farmer's important position in today's economy.

In his talk Mr. Stambaugh pointed out that, while the nation is producing on essentially the same acreage of land as for the period 1935-39 (the base period), actually 140 per cent production is needed. During the time that has elapsed since the base period, the industry of agriculture has lost 12 per cent of its labor, and its animal power has been markedly reduced. Nevertheless the industry has been able to overcome this handicap by using 250 per cent more machinery, 300 per cent more fertilizer, 600 per cent more electric power. The speaker further pointed out that only through cooperation of manufacturing and service industries was it possible for agriculture to meet the demands upon it.

Mr. Stambaugh further pointed out that agriculture is the largest user (outside of the Army) of critical materials. He presented a vivid picture of the complications of these controls, and how it is impractical to use historical records since many of the more than 1600 manufacturers are relatively new in the field, yet they are filling a very definite and important need. As an example, he cited *(Continued on page 624)*

Now! A Low-Cost TANDEM DRIVE Motor Grader *for Terracing*

Allis-Chalmers Model D . . . A Natural on Conservation Jobs

Ownership of a *tandem drive* motor grader for building terraces and farm ponds, other dirt handling, is made economically practical for conservation districts, ranches and farm contractors with limited funds.

The Allis-Chalmers Model D has *tandem drive* and other features formerly found only in motor graders costing up to three times as much. Its great traction, convenient size and easy operation make it a "natural" for low-cost terracing work, ditching and farm road maintenance.

Has plenty of power to move big loads fast . . . makes smooth, even grade . . . maneuvers easily. Quickly goes from one job to another — travels up to 18.6 mph.

And the Model D is at home in any farm community. Its Allis-Chalmers 34.7 hp. gasoline engine is well known as a top performer in tough farm tractor service. Maintenance cost is low. Any mechanic can service it . . . parts are carried by all A-C tractor dealers.

Write for a free catalog on this low-cost, *tandem drive* motor grader, or get the full story from any Allis-Chalmers industrial tractor dealer.

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- Weight — 8,500 lb.
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ROLL-AWAY is an Allis-Chalmers trademark.

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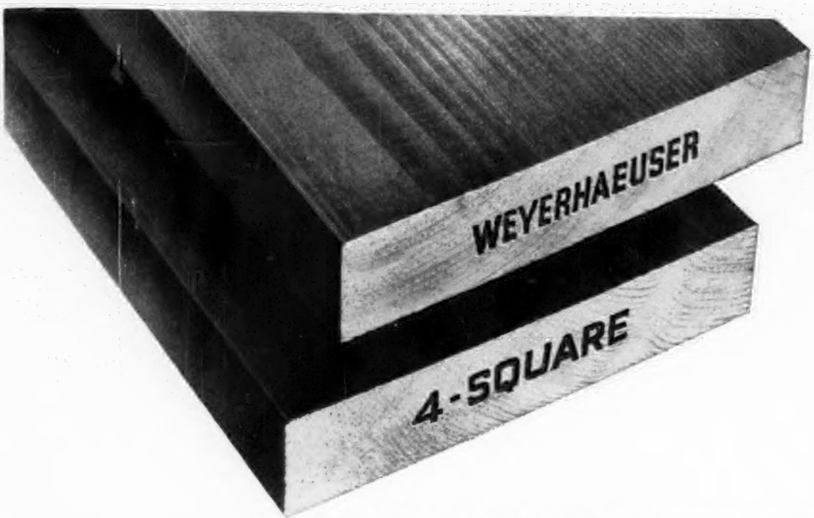
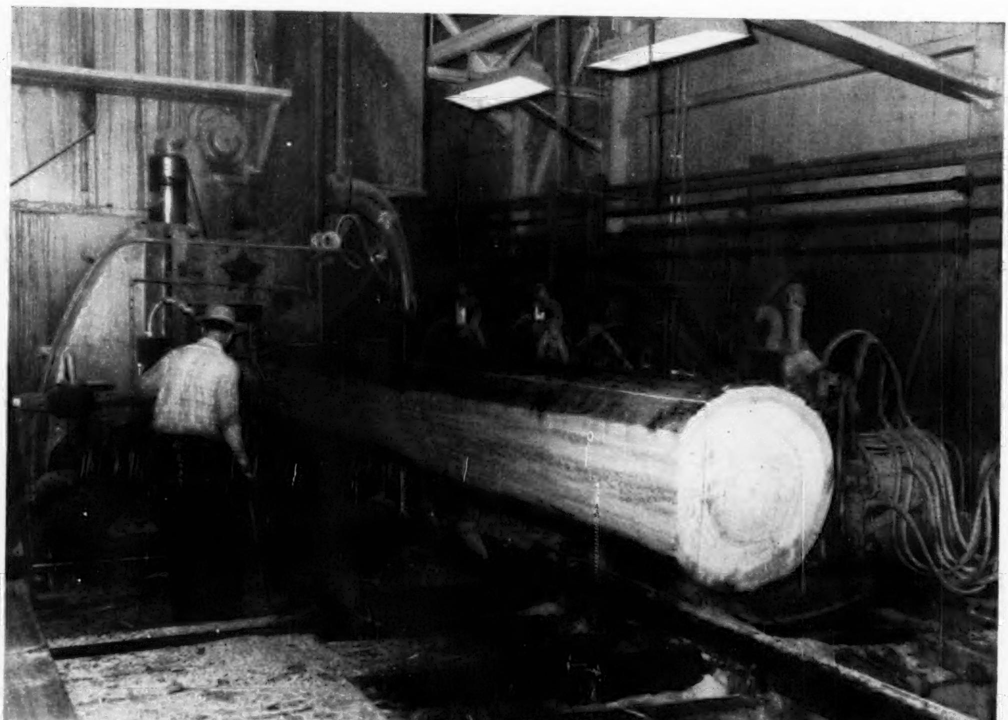
Newest, Finest Crawler Tractor Line On Earth — four sizes, 11,250 to 41,000 lb. . . . with matched Allied equipment for every purpose.



THIS BRAND NAME ON LUMBER MEANS . . .



NEWS SECTION (Continued from page 620)

sprinkler irrigation, and stated that large sums of money have been expended for land leveling and conditioning equipment; also, that water has been secured, but without sprinkler equipment no benefit from these expenditures can be realized.

He lauded the agricultural engineers, both those associated with government and industry, for their part in the high degree of mechanization that has been achieved on America's farms. Stambaugh believes that agriculture will get its fair share of future allotments of critical materials if we are able to conserve enough of them, through research developments of new products and new methods that will help to reduce the demand for them. He believes this is the important role agricultural engineers can play in the years ahead.

It was reported at the meeting that the Section is giving consideration to an invitation from the District of Columbia Council of Engineers and Agricultural Societies to make application for membership on the Council.

The next meeting of the Section is scheduled for Friday, November 9, at 11:55 a.m., in Room 6962 of the South Agriculture Building. The speaker for the occasion will be the Hon. Knox T. Hutchinson, Assistant Secretary of Agriculture, who will speak on the function of machinery and equipment in meeting the production goals of agriculture. The chairman for the program will be Dr. Truman E. Hienton, head, farm electrification division, USDA.

Chicago Section Urbana Meeting

ASAE Chicago Section members and guests paid a visit, October 1, to the agricultural engineering department of the University of Illinois at Urbana. The occasion was the annual field day and business meeting of the Section.

A tour of the department's field research facilities occupied the morning period. It included stops at the University dairy barns, plots for machinery research, bin site for crop conditioning research, and plots for runoff studies.

Guests of the Section at a noon luncheon included Dean Rusk of the college of agriculture, Dean Everett and Associate Deans Pierce and Jordan of the engineering college, Dr. Howard, associate director of the agricultural experiment station, Stanley Madill, president of ASAE, four members of the agricultural engineering advisory committee, University of Illinois, staff members of the agricultural engineering department, and 26 members of the Illinois Student Branch of ASAE.

Brief descriptions of the department's research in progress in 15 different projects were presented in the afternoon session.

New Section officers elected during the business meeting are: C. L. Hamilton, chairman; Howard C. Rutt, Fred A. Lyman, and L. G. Samsel, vice-chairmen; Lee H. Ford, secretary-treasurer; and John Wessman, L. W. Garver, and K. W. Snyder, nominating committee.

Engineering in Farm Safety Program

ENGINEERING aspects of farm safety were re-emphasized in farm section sessions of the 39th National Safety Congress, October 8 to 12. They were especially featured in the session on the general theme "Some Technical Problems of Farm Safety."

A. J. Schwantes (past president ASAE), head of the division of agricultural engineering, University of Minnesota, addressed the opening session on opportunities of the agricultural colleges to promote farm safety. He invited attention to a report indicating that farm safety includes "the safeguarding of farm people from all accidents to which they may be exposed." He pointed out that the colleges have an opportunity and responsibility for promoting farm safety through resident instruction and research as well as through their extension activities.

S. P. Lyle (past-president ASAE), agricultural engineer, Extension Service, U.S. Department of Agriculture, presided at a session giving attention to ways and means of encouraging farmers to show a more active interest in safety for themselves and their families.

Tractor Stability as a factor in safe tractor operation was discussed and demonstrated for Wayne H. Worthington, director of engineering research, John Deere Waterloo Tractor Works, by one of his assistants. Influences of slope, obstructions, wheel weights, attached loads, and height of hitch point on the tendency of a tractor to turn over, and simple operating methods of reducing these hazards, were demonstrated with models.

Other technical matters covered on the program included colors for hazard and safety markers, testing for safety, accident surveys, and accident liability of farmers.

Extension Committee Activity

IN A SESSION during the American Society of Agricultural Engineers' annual meeting at Houston, Tex., in June, the Committee on Extension considered a variety of suggestions for continuation and expansion of its activities. One suggestion favored some outstanding activity which would draw public attention to the Society and its service to agriculture.

Several of those present suggested adoption of some symbol of ASAE approval for individual items of various types of visual aid extension material. The thought was that use of the symbol on or with the material would be authorized to show that it was judged to measure up to some predetermined standard of excellence as an extension aid.

An exhibit during the Winter Meeting of the Society in Chicago was also suggested, as a means of making the Committee's activities better known to members who attend that meeting but not the Annual Meeting. It was mentioned that pictures of previous bulletin displays and award winners, or the actual winning exhibits and blue ribbons, might appropriately be exhibited at the Winter Meeting.

Four textbooks were mentioned as already entered for display next year. It was brought out that, in the case of textbook exhibits, the Committee should have opportunity to preview the books before accepting them for exhibit.

Additional emphasis on the suitcase size of exhibit popular with many extension men was suggested for committee consideration.

In connection with a renewal of attention to promoting cooperation between industry and public service extension workers, it was proposed that a set of suggestions or patterns for successful cooperative promotion of new agricultural practices be developed.

It was further proposed that the Committee's score sheet on educational moving pictures be made available as a guide to public and private agencies planning new productions for use in extension programs.

L. G. Samsel (J. I. Case Co.) who had served as chairman of the Extension Committee for the past several years, and had led it into a full program of constructive activity, retired as chairman at his own request at the end of the meeting. The new chairman is K. H. Hinchcliff (University of Illinois) who will be assisted by T. E. Long (Portland Cement Assn.), as vice-chairman.

PERSONALS OF ASAE MEMBERS

Ryland Y. Bailey, a 1951 agricultural engineering graduate of Virginia Polytechnic Institute, and presently a second lieutenant in the U.S. Air Force, recently began special study in meteorology at Massachusetts Institute of Technology at Cambridge.

Wesley F. Buchele is on leave from the University of Arkansas, where he is assistant professor of agricultural engineering, to do graduate work in agricultural engineering at the Iowa State College under Prof. E. V. Collins.

Earl Alfred Crouse, a 1951 graduate in agricultural engineering from University of Maryland, has accepted appointment as instructor and extension specialist in agricultural engineering at the University of Delaware, Newark.

Julian M. Fore has resigned as the head of the education section in the agricultural engineering and processing section of the Tennessee Valley Authority, and is now promotional sales manager for the agricultural division of Aerovent Fan & Equipment, Inc., manufacturers of engineered crop-drying and ventilation equipment, Lansing, Mich.

Richard E. Griffin resigned recently as engineer in the Utah State Engineer Office to accept employment with S/A Industrias Reunidas F. Matarazzo, Sao Paulo, Brazil, as irrigation engineer. The farm on which he is working is 9,000 acres in area with about 6,000 acres under cultivation and somewhat less under irrigation. The main crops in order of size are sugar cane, tomatoes, and coffee. The property includes a tomato canning factory, sugar refinery, citric acid plant, and an alcohol plant.

Karl R. Klingelhofer has taken a new position in engineering work with the Illinois State Water Survey Division. He was formerly in agricultural engineering work with the U.S. Soil Conservation Service.

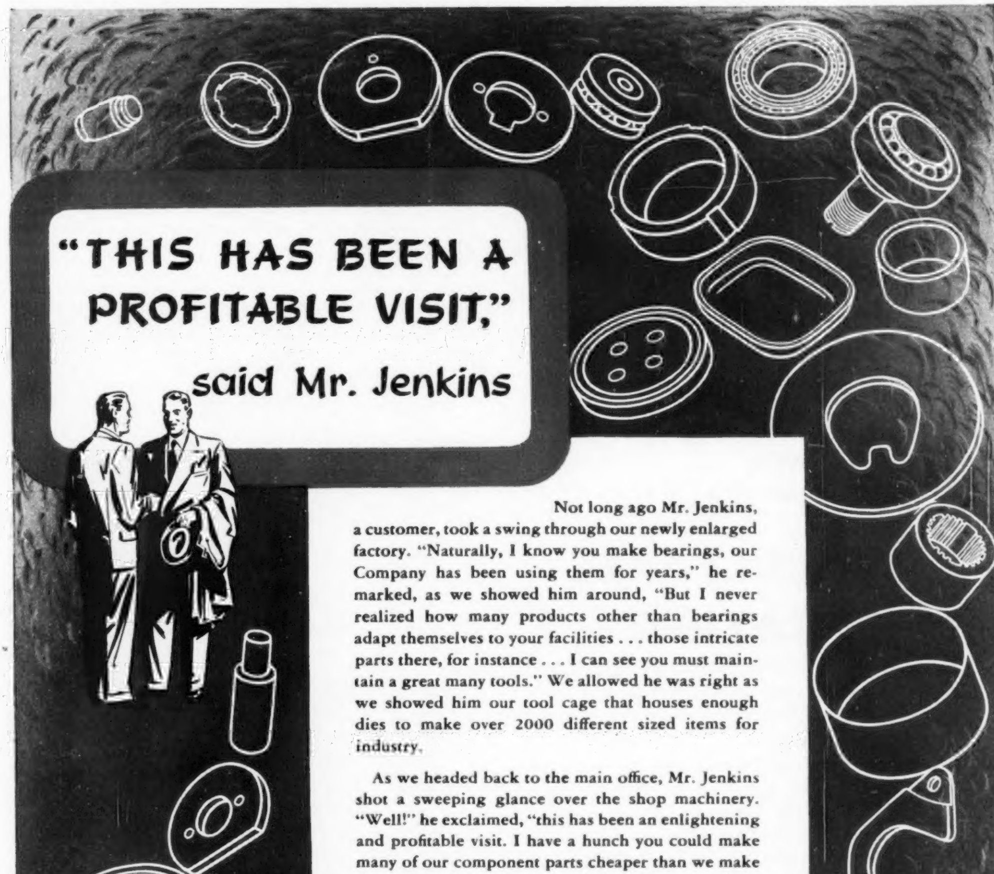
Fred W. Knipe, who has been engaged in special work for the International Health Division of The Rockefeller Foundation on the Island of Sardinia for some years, has been assigned by the Foundation to a year of study in the United States, and is enrolled at Pennsylvania State College as a graduate student in agricultural engineering. At the end of his leave next summer he expects to return to the project in Italy.

Stanley W. McBirney has been transferred from the Colorado A. & M. College, where he was in charge of the sugar beet development project of the U.S. Department of Agriculture, to the University of Missouri, Columbia, where he will head up a cooperative national weed machinery project between the USDA and the University of Missouri.

Robert W. Okey is engaged in irrigation engineering work with the U.S. Bureau of Reclamation at Toppenish, Wash. Previously he was a graduate student at Iowa State College.

Wm. Vutz recently resigned as chief engineer of the New Idea Division Avco Mfg. Corp., to accept appointment as director of engineering of the Mount Vernon Implement Co., Stamford, Conn.

Homer D. Witzel recently returned to the Midwest to accept a position as project engineer at the John Deere Harvester Works, East Moline, Ill. He was formerly factory manager, Harris Mfg. Co., Stockton, Calif.


"THIS HAS BEEN A PROFITABLE VISIT,"
said Mr. Jenkins
Not long ago Mr. Jenkins, a customer, took a swing through our newly enlarged factory. "Naturally, I know you make bearings, our Company has been using them for years," he remarked, as we showed him around, "But I never realized how many products other than bearings adapt themselves to your facilities . . . those intricate parts there, for instance . . . I can see you must maintain a great many tools." We allowed he was right as we showed him our tool cage that houses enough dies to make over 2000 different sized items for industry.
As we headed back to the main office, Mr. Jenkins shot a sweeping glance over the shop machinery. "Well!" he exclaimed, "this has been an enlightening and profitable visit. I have a hunch you could make many of our component parts cheaper than we make them ourselves." We agreed, because we've been doing just that for many of the giants of American industry year after year.
It might surprise YOU, too, to see how complete and versatile our equipment really is—to know how many ways it can serve you profitably. We would enjoy having you visit our plant . . . or in being asked to talk things over at your plant. Aetna Ball and Roller Bearing Company, 4600 Schubert Avenue, Chicago 39, Illinois.
Aetna
Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts.

NEW BOOKS

SAE HANDBOOK (1951 edition). Cloth, 864 pages, 8½ x 11 inches. Illustrated and indexed. Society of Automotive Engineers (29 W. 39th St., New York 18, N. Y.)

Larger page size represents a major improvement over previous editions, providing increased legibility of illustrations and tables. Subject matter is regrouped under general headings — the Society, ferrous metals, non-ferrous metals, non-metallic materials; threads, fasteners, and common parts; electrical equipment, power plant components and accessories; passenger cars, trucks, and busses, tractor and earthmoving equipment, marine equipment, miscellaneous, SAE designations, organizations referred to in SAE Handbook, index, and index to advertisers. New and revised specifications are indicated in their places in the complete table of contents. New material covers low-temperature properties of ferrous metals, automotive rubber mats, temperatures for recommending gear lubricants, and several items under electrical, power plant, passenger car, and tractor headings. Revisions outnumber the new specifications and are found under all of the main subject headings. New and revised specifications in the section on tractor and earthmoving equipment cover spark arresters for internal-combustion engines, tractor and implement disk wheels, grader cutting edge, bulldozer cutting edge, industrial (track-type) tractor drawbars, rear power take-off and mounting face for industrial (track-type) tractors, and haulage and grader tires and off-highway rim classification.

AGRICULTURAL MARKET PRICES, by Warren C. Waite and Harry C. Trelogan. Second edition. Cloth, ix + 440 pages, 6 x 9 inches. Illustrated and indexed. John Wiley and Sons, Inc. (440 Fourth Ave., New York 16, N. Y.) $5.25.

This is an advanced text and reference dealing with the nature, causes, and extent of farm commodity price variations estimated to be of primary interest to the agricultural business man. From an engineering viewpoint it reflects an experimenter's preoccupation with the mechanism of prices rather than a production man's drive for volume and quality of output at low unit cost, favorable to profitable business at low prices. While it does not pretend to deal with operating factors other than prices, it might have dealt more adequately with prices as a factor in demand and a guide to farm production objectives.

WHAT TO MAKE WITH CONCRETE. Cloth, 112 pages, 6¾ x 9¼ inches. Illustrated and indexed. Popular Mechanics Press (200 East Ontario St., Chicago 11, Ill.) $2.00.

Covers general information, special projects, home-made power mixer and concrete block machine, projects for house and garden, concrete on the farm, and fifty tested short cuts.

FARMING MACHINERY, by A. B. Lees. Cloth, 220 pages, 6 x 9 inches. Illustrated and indexed. Faber and Faber, Ltd. (24 Russell Square, London, W.C. 1) 21/.

A general reference rather than a specific text or instruction manual, this book discusses from a British viewpoint, trends, developments, values, and applications to a greater extent than maintenance or methods of operation. Chapters cover why and who, muscle or metal, British tractors, mounted implements, plough performance, seed and fertilizer distribution, manure handling, to exploit grass, haymaking, grain harvesting and drying, cultivations, root harvesting, safer crops by spraying, rain on tap, farm transport, less labor in milk production, mills — hammer or plate, electricity — modern slave, mechanical hedge cutting, mechanized poultry farming, maintenance, situations vacant, and conundrums of capital.

SOIL TESTING FOR ENGINEERS, by T. William Lambe. Cloth, ring bound, ix + 165 pages, 8½ x 11 inches. Illustrated and indexed. John Wiley and Sons, Inc. (440 Fourth Ave., New York 16, N. Y. London: Chapman and Hall, Ltd.) $5.00.

This is a text and reference on the subject covering specific gravity test, Atterberg limits and indices, grain size analysis, compaction test, permeability test, capillary head test, capillary permeability test, consolidation test, direct shear test on cohesionless soil, triaxial compression test on cohesionless soil, unconfined compression test, and direct shear test on cohesive soil. Nomenclature and symbols follow the ASAE recommendations for soil mechanics nomenclature. Appendices cover conversion factors, specific gravity of water, viscosity of water, proving rings, drawing of liquid limit device, and derivation of equations.

PROCEEDINGS OF THE NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS, 1950 (vol. IV). Paper, XXVII + 347 pages, 6 x 9 inches. Illustrated. National Conference on Industrial Hydraulics (Technology Center, Chicago 16, Ill.) $3.50.

Complete text of all technical papers (20) presented at the sixth meeting, October, 1950, together with miscellaneous information on the Conference. The papers deal variously with design and control problems, operation and care, and operating experiences, in connection with such phenomena of fluid dynamics as flow characteristics, cavitation, liquid hammer, and surge relief; system components such as pumps, bubble trays, rotameters, accumulators, gates and valves, hose assemblies and fittings, packings, and shock stops; and applications to automatic transmissions, aircraft, dredges, presses, sewage pumps, and tractors.

NEW BULLETINS

Farm Electrification Research, Edison Electric Institute, (420 Lexington Ave., New York 17, N. Y.) $1.00. This is a revised report on special studies and research contributed to or conducted by electric operating companies from January, 1947, to December, 1950. In it the Farm Section of the Institute brings up to date an earlier report published in December, 1949. It is a 50-page, 8½ x 11-inch booklet giving brief information on 89 projects completed or in progress, on a variety of heat, light, power, and miscellaneous applications.

The Estimation of Extreme Flood Discharges by Statistical Methods, by A. D. Benham. Reprinted from the Proceedings (vol. 36, 1950) of the New Zealand Institution of Engineers (Wellington). A technical presentation of some statistical methods, supplemented by discussion by several other authorities.

Wood Box Columns and Their Design, by B. Y. Kinzey, Jr. Bulletin of the Virginia Polytechnic Institute (Blacksburg) (July, 1951). This is a somewhat more extensive treatment of the subject than the previously noted reprint of a paper by the same author.

Some General Considerations in the Natural Ventilation of Buildings, by W. W. Candill, S. E. Crites, and E. G. Smith. Texas Engineering Experiment Station (College Station) Research Report No. 22 (February, 1951). This report brings together in convenient form basic information on air movement in and around buildings, as a reference for architects and engineers. Emphasis is on facilitating air movement for summer comfort in the Southwest.

Some Fundamental Plant-Soil-Water Relations in Watershed Management, by Leon Lassen, Howard W. Lull, and Bernard Frank. Forest Service, U.S. Department of Agriculture, (Washington, D.C.) (July, 1951). Deals with the soil as a storage reservoir, influence of vegetation on retention storage opportunity, soil water movement and temporary storage, and application to watershed management.

Annual Report — Research and Investigational Activities (College of Agriculture, University of Georgia, Athens, for the fiscal year ending June 30, 1950). An 18-page section of agricultural engineering includes brief reports on work on small abatoirs in Georgia, sweet potato dehydration, a corn silker, a corn cutter, drying cured pork, grain elevators, factors affecting the design for an egg cooler, developing a peanut combine harvester, shade tobacco (cigar wrapper) curing studies, flue cured (bright) tobacco curing studies, field drying rates of standing corn, sweet potato storage study, blue lupine seed drying, a culvert-pipe grain and seed drier, grain storage facilities in Georgia, and supplemental irrigation.

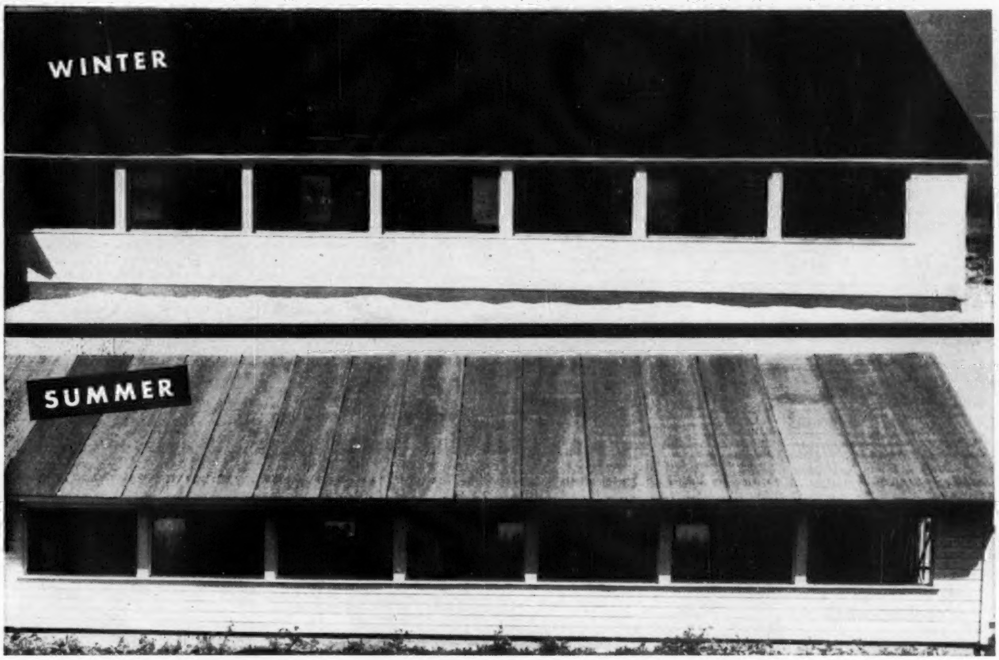
Cotton Harvesting in the Southeast

(Continued from page 612)

tion of such an expensive machine by the average Alabama farmer. Hence, we were looking for a machine in a more suitable price range for the majority of our farmers. The results were not altogether discouraging. During the two seasons of 1948 and 1949, many problems became apparent. First, it was found that cotton cannot be harvested mechanically unless plans are made for it in the spring. Land preparation, plant spacing, cultivation, and defoliation have a decided effect upon the success of any mechanical harvester. Our success with strippers has been neither spectacular nor discouraging. The grades of stripped cotton were quite low, ranging from strict good ordinary to low middling.

This year we are making plans for a rather intensive stripper-type harvester development program in Alabama. We have definite assurances for at least four experimental cotton strippers employing different principles. Our experiment substations are cooperating with us in this program by providing the necessary facilities so that we will begin the harvest work about the middle of August in Southeast Alabama and follow the season through November as we move northward in the state to the Sand Mountain and Tennessee Valley substations. By combining our efforts with those of the South Carolina station, we hope to have a better picture of cotton-harvesting possibilities in the Southeast than we have at present.

It is not my intention to say at this time where we are going in cotton harvesting in the Southeast. It may be pickers, or it may be strippers, or it may be some other device. What I would like to emphasize, however, is that it must be within reach of the average southeastern farmer. In my opinion, the cost of a combine would not be prohibitive for a cotton harvester. With a minimum wage-hour law of 75c in existence and $1.00 per hr or more in the offing, we cannot very well maintain a competitive position picking cotton by hand.



How farm buildings can have sun heat *only* when it's needed

You know the value of sunshine to keep farm buildings warmer and drier in winter. But you don't want sun heat in summer.

This solar poultry house shows how you can bring in sunlight when you want it. See the shadow lines. Notice how the roof overhang shades the windows from most of the summer sun, but lets sunshine stream through the windows in winter. This difference is possible because the sun is so much lower in the sky in winter.

There are several rules to follow in planning a solar building:

1. Use large windows, facing south, to flood the interior with warm sunshine in winter from sunrise to sunset.
2. Insulate those windows with *Thermopane** insulating glass. *Thermopane* helps keep buildings warmer and drier in winter. It reduces condensation on windows and thus helps keep down maintenance costs.
3. Use a roof overhang. It should be designed to meet both requirements—summer shading and winter sunlighting. We have developed a Sun Angle Calculator with which you can determine proper size of shading devices for various latitudes. (Described at right)

Thermopane is easily installed—in fixed or opening sash. It is sold by glass and building supply distributors and dealers.

Sun Angle Calculator—Libbey·Owens·Ford and Aeronautical Services, Inc., have together developed a device which enables you to answer problems in sun control. It is simple to use—works for latitudes 24° to 52° North—for walls facing any direction. You can figure depth of sun penetration into a building. Also estimate solar heat gain. Available at $9.50. Since this is less than cost, be sure your letterhead stating your profession accompanies your order and check.

FREE FOLDER

"IMPROVED FARM BUILDING DAYLIGHTING"

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Please send me:

☐ Improved Farm Building Daylighting.
☐ Information on your Sun Angle Calculator.

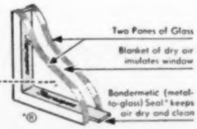
Name ____________________
(PLEASE PRINT)

Address ____________________

Town ____________ State ____________

LOF GLASS *Thermopane*

LOOK FOR THE NAME ON THE SEAL BETWEEN THE PANES

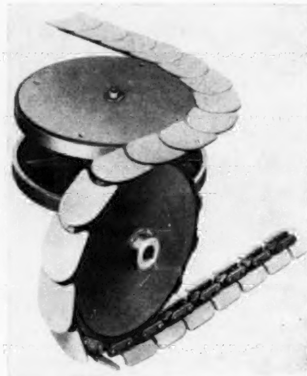


NEWS FROM ADVERTISERS

New Products and Literature Announced by AGRICULTURAL ENGINEERING Advertisers

Alcoa Irrigation Booklet. "Pipelines to Profit" is a 24-page brochure issued by the Aluminum Co. of America, Pittsburgh, Pa., to help farmers learn more about portable sprinkler irrigation — what it is, where it is being used, and how it may be used profitably on their farms. It is attractively printed and illustrated in color. Brief information is given on the use of sprinkler irrigation on pastures, truck and general farms, orchards and groves; water supply, pumping plant, field supply line and distribution line requirements; costs, layout, when and how much to irrigate, and care of equipment. The booklet closes with a note that the planning of an efficient sprinkler irrigation system is an engineering job on which the farmer will find it profitable to secure sound advice from an engineer experienced in irrigation.

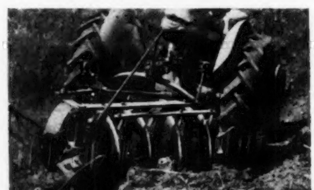
New Chain Belt Conveyor Chain. A new flat-top conveyor which flexes in two planes — both horizontally and vertically — and can curve around corners with a radius of as little as 6 in with ease, is now being marketed by Chain Belt Co., Milwaukee, Wis., under the name, Rex FlexTop. Designed primarily for tip-free conveying of bottles, jars, packages or small parts, the biggest advantage of FlexTop is its elimination of transfer points in the conveyor system. It does away with the danger of containers being chipped, tripped or otherwise damaged as they transfer from one chain or one conveyor to another. A FlexTop conveyor can be driven from one power source, within limits of chain loading, eliminating the need for transmission parts at transfer points. Carbon or stainless steel crescent-shaped top plates are mounted on links which are connected by a specially designed universal joint. Top plates are induction welded to the chain links. The chain operates over special cut-tooth sprockets. It operates around horizontal idler disks of 14-in diameter at corners. Two disks are used at each corner, one for the carrying strand and one for the returning strand. The speed at which the chain can be run is determined by the product being handled and by the length of the conveyor. The Company offers additional information on this new product in Bulletin 52-60.



Rex FlexTop Chain flexed in two planes

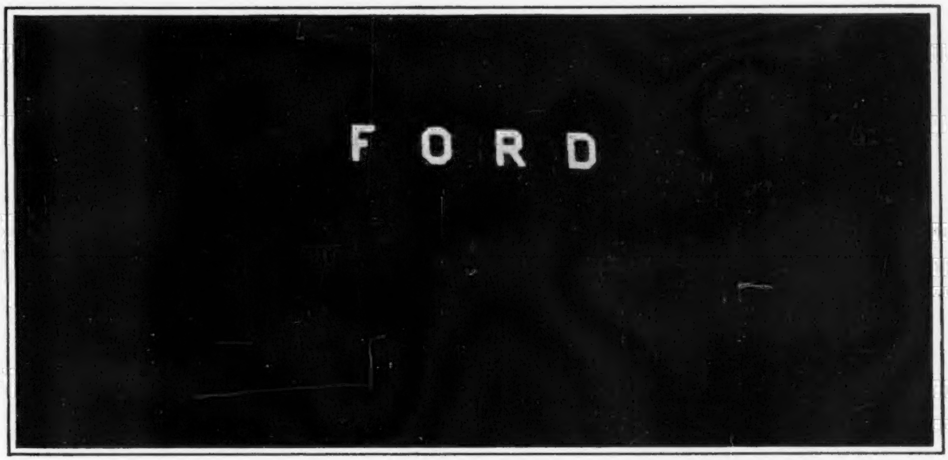
• • •

Lift-Type Taylor Disk Tiller. This is a heavy, rigid-frame implement for fast breaking in a wide variety of field and soil conditions, recently added to the line of implements of the Dearborn Motors Corp., Birmingham, Mich. The Taylor disk tiller is quickly attached to the Ford tractor by means of three hitch links and a stabilizer bracket and is lifted and lowered by Ford tractor hydraulic touch control. The 10-in spacing of the four disks mounted on a strong, rigid frame fits this tiller for a wide range of jobs. It also meets the tillage needs



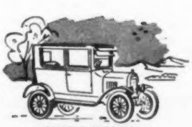
Lift-type Taylor disk tiller engineered for use with the Ford tractor

of mulch farming. High frame clearance minimizes "trashing up" and adapts it to turning under cover crops. On summer fallow work, the tiller can be set to work shallow for weed control at stepped-up tractor speeds. The tiller's large earth-moving capacity adapts it to building terraces or filling gullies. Another feature is a rear wheel designed to act as a rudder by means of a steering link, assisting the tiller to follow the tractor and give more uniform width of cut. Operating depth is controlled by the Ford tractor's hydraulic mechanism, or may be (Continued on page 632)



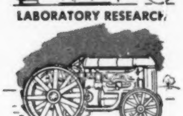
What the Ford Name means to those who feed America!

Ford TRACTOR

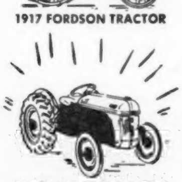


MODEL T FORD

LABORATORY RESEARCH



1917 FORDSON TRACTOR



TODAY'S FORD TRACTOR

From the beginning, the name "Ford" has identified a company that understands the needs and wants of farmers. To millions of farmers, the Ford name recalls the cars and trucks that could "get through"—and Ford-built tractors that took away much of the drudgery of farming.

With the mass production of the Model T Ford came new and better farm markets—bringing a practical way to carry farm youth to a better education—and opening new vistas and opportunities for the entire farm family.

The Ford name means the millions of dollars that went into research for crops convertible into industrial products and for ways of converting them.

But many farmers regard the tractor, prime source of farm power, as a still larger Ford service to agriculture.

For the Fordson Tractor that came on the market in 1917 was the world's first mass-produced, really low-priced tractor. Fordsons went to the farms over half a million strong—powerful proof that they met basic needs.

The name "Ford" on a tractor today means engineering experience, manufacturing skill, and volume production resources that few machines in any field command. These account for the Ford Tractor's high quality, fine performance, high resale value and leadership in low price.

DEARBORN MOTORS CORPORATION • Birmingham, Michigan

National Marketing Organization for the Ford Tractor and Dearborn Farm Equipment

Dearborn EQUIPMENT

Ford Farming

MEANS BETTER WORK
. . . MORE PRODUCTION

NEWS FROM ADVERTISERS

(Continued from page 630)

controlled by a land-wheel attachment sold separately. Leveling of the tiller is accomplished by means of the tractor leveling crank.

• • •

Concrete Farm Structures Booklets. Portland Cement Association (33 W. Grand Ave., Chicago 10, Ill.) has recently issued two new booklets on farm use of concrete. "Building Concrete Farm Structures" is a manual of recommended practices on building with concrete masonry and making quality concrete. "Construction Details for Concrete Farm Structures" embodies drawings which can be traced directly into plans. It includes details for windows, doors, lintels, cornices, piers, and pilasters, control joints, ventilator openings, footing, floors, and paving. Copies of the first booklet and individual unbound detail sheets from the second are available to engineers, draftsmen, and students, on request. Copies of the bound book of details are available to drafting and engineering department heads and to teachers of college classes in farm buildings.

• • •

Stow Flexible Shafting Engineering Data. Stow Manufacturing Co., has issued this Bulletin 515 as an aid in considering flexible shafting for power transmission and remote controls in the early stages of design of new products. It shows typical applications and gives engineering data, including tables for calculating torque and deflection, integral design connections, and applications of standard power drive shafts to solve power transmission problems where it is impracticable to re-design the equipment. Available to design engineers on request to Stow Mfg. Co., 39 Shear St., Binghamton, N. Y.

• • •

International Nickel Bulletin. "Engineering Properties and Applications of Ni-Resist" is a 36-page bulletin describing eight types of austenitic nickel alloy cast irons. Applications and comparative service data in many industrial fields are presented as to its utility in withstanding corrosion, heat, wear and low temperature. High or low-controlled expansion, magnetic or non-magnetic properties and resistance to thermal shock add variety to its usefulness. Text, graphs, photos and tables related properties to nearly 400 combinations of conditions. International Nickel, Dept. EZ, New York 5, N. Y.

• • •

Steel Serves the Nation. United States Steel Corp. tells the story of its fifty years of service in a commemorative book of 227 9 x 12-inch pages of narrative and illustration. In picturing the development and progress of this one company the book inevitably brings together much of the history of the whole industry for the period. Chapters cover origin and formation, growing with America, two World Wars, research for progress and security, the human element, public relations, raw materials for iron and steel, making iron and steel, structural steel and plates, sheet and strip steel, steel for railroads, wire and wire products, pipes and tubes, steel and cement in construction, fabricating services, world-wide service, and department stores for steel. The book should prove a valuable historical reference on the steel industry as a whole, and on the United States Steel Corp. and its subsidiaries in particular.

• • •

Dearborn Bush and Bog Harrow. Dearborn Motors Corp., Birmingham, Mich., has added to its line a new bush and bog harrow built with ample strength to slash through tough, tall surface growth and heavy trash. The main frame is a 4-in square steel bar with disk supports welded to it. Weight on each of eight cutout blades is 95 lb which enables it to slash down pasture brush and rank cover crops. It is useful in chopping stalks and stubble of last year's crops to speed land preparation. Available in three disk sizes — 20-in, 22-in, and 24-in — the harrow weighs

Dearborn bush and bog harrow

from 744 to 840 lb according to the size disk selected. The disks are cross-rolled, high-carbon steel, heat-treated for strength and resistance to wear. Extra-heavy-duty bearings are of cast white iron. The harrow is quickly attached to the Ford tractor and is controlled by the Ford tractor hydraulic mechanism. The top link bracket assembly is adjustable for lowering of center disks in relation to outer disks, which permits up to $3\frac{1}{2}$ in deeper penetration for center disks. The disk angle can be set at 18 or 24 deg to suit working conditions.

FARM INSTITUTE

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P. O. Box No. 1800
Louisville 1, Kentucky

REYNOLDS FARM INSTITUTE DISPLAY COACH CARRIES FARM BUILDING EDUCATION TO THE FARMERS!

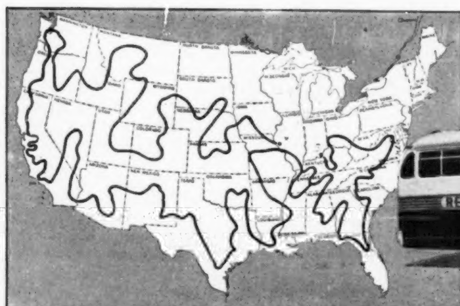
An important feature in the educational program of Reynolds Farm Institute is a traveling exhibit of aluminum farm building products, in a specially designed motor coach. On the road continuously, the coach has already completed the itinerary outlined on the map below. Thousands of county agents, vo-ag teachers and other agricultural leaders — together with many more thousands of farmers — have seen the display and heard authoritative discussions on the benefits of aluminum in modern farming.

One side of the coach interior displays aluminum building products with emphasis on the visual teaching of proper application. On the other side are models of pole-frame construction and of aluminum re-roofing and re-siding on conventional buildings. Working drawings of newly developed "adaptor plans" are distributed free, with other informative literature.

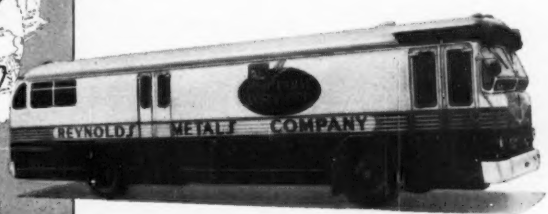
In exhibitions at vo-ag schools, land grant and other colleges, county agent meetings and various farm organization affairs, the profit-value of aluminum's heat reflectivity was widely recognized. More milk from cooler cattle, more weight on cooler hogs, more income where poultry is protected from excess heat... these were summer benefits cited, in addition to fuel savings in winter. The virtual elimination of maintenance with rustproof aluminum was also emphasized.

The Reynolds Farm Institute Display Coach will continue its travels — bound for the Northeastern States this fall. The Institute's representatives will be in touch with farm leaders to coordinate its itinerary, so far as possible, with meetings already planned.

REYNOLDS FARM INSTITUTE



Itinerary of the Display Coach, July 1950 to August 1951



APPLICANTS FOR ASAE MEMBERSHIP

The persons listed below have applied for admission to membership, or for transfer of membership grade, in the American Society of Agricultural Engineers. Members of the Society who wish to commend or object to any of these applicants, should write the Secretary of the Society at once. If there are no objections, and if confidential statements furnished by their references are satisfactory, these applicants will be voted on by the Council after December 15, 1951.

ABELE, RICHARD D.—2nd Lt., U.S. Army. (Mail) RR 1, Adamsville, Ohio

ALEGRE, ARMANDO C.—Chief agr. engr., La Antillana, Havana, Cuba

ARDEN, ALPHONSO W.—Irrigation engr., W. R. Ames Co., San Francisco, Calif.

BAILLIE, JAMES C. N.—Chief dev. engr., North of Scotland Hydro-Electric Board, Edinburgh, Scotland.

BHATIA, I. L.—Asst. mechanical engr., Central Tractor Organization, New Delhi, India

BOONLU, JOHN—Irrigation engr., Royal Irrigation Dept., Bangkok, Thailand

BURNSIDE, BRADLEY A.—Product engr., American Lumber & Treating Co., Chicago, Ill.

CARLSON, EARL W.— Agr. engr., Public Service Co. of No. Ill., Lacon, Ill.

COOK, ALBERT W.—Agr. engr., Appalachian Electric Power Co., Roanoke, Va.

DE ALMEDIA LEME, HUGO—Prof. of agr. machinery, University of Sao Paulo, Piracicaba, Brazil, S. A.

ELIASON, KAY E.—Owner, Kay Eliason—Farm Drainage, Jefferson, Ia.

ELLIOTT, GORDON R.—Gen. sales mgr., Wisconsin Tractor & Equipment Co., Fond du Lac, Wis.

FINK, MILTON—Rural sales dir., Metropolitan Edison Co., Reading, Pa.

FOSS, ROBERT A.—Trainee, Caterpillar Tractor Co., Peoria, Ill.

GOODNIGHT, HARROLD W.—Automotive engr., The Standard Oil Co., Cleveland, Ohio

HALL, JAMES W.—Dist. agr. engr., Appalachian Electric Power Co., Roanoke, Va.

HARPER, JOHN M.—Mgr., E. W. Tarry & Co., Ltd., Bulawayo, Southern Rhodesia, Africa

HILDEBRAND, THOMAS F.—American Gas & Elec. Service Corp., New York, N. Y.

HINKLE, CHARLES N.—Graduate asst., agr. eng. dept., Michigan State College, East Lansing, Mich.

IYER, C. S.—Tractor engr., Govt. of Madhyapradesh, Nagpur, India

JAHR, EVERETT C.—Agr. engr., Soil Conservation Service, USDA, Berkeley, Calif.

KIMBROUGH, EMMETT A., JR.—Inst. in agr. eng., Mississippi State College, State College, Miss.

KRIEGER, JOSEPH C.—Trainee, Allis-Chalmers Mfg. Co., Indianapolis, Ind.

MANKU, J. S.—Asst. engr. in agr. eng. dept., Indian Agr. Res. Institute, New Delhi, India

NELLES, MAURICE—Director of research, Borg-Warner Central Research Laboratory, Bellwood, Ill.

NORDLINGER, ERNEST W.—Asst. editor, Food Processing, Chicago, Ill.

PATZER, NEIL H.—Farmer, RR 1, Cardington, Ohio

ROTH, LAWRENCE O.—Instructor in agricultural engineering, Oklahoma A. & M. College, Stillwater, Okla.

SOUTHER, WILLIAM H.—Mgr., Sunnyside Concrete Pipe Co., Sunnyside, Wash.

SRIVASTAVA, RAM N.—Reclamation asst., Soil Conservation Dept., DVC, Hazaribagh, Bihar, India

Grassland Farming Meeting

THE annual meeting of the Joint Committee on Grassland Farming, on which ASAE is represented as one of the cooperating organizations, will be held at the La Salle Hotel, Chicago, on November 28. A distinguished list of speakers will discuss a variety of subjects, including grassland farming in its national aspects, a common sense meat program with grassland farming, grass silage preservatives, the 1952 International Grassland Congress, fifteen years' work with grass-animal-agriculture, milk from grass, grassland farming in the South, and Wisconsin's pasture program. Copies of the program for this meeting may be had upon request to the secretary of the Committee, Z. W. Craine, Norwich, N. Y.

NEW BULLETINS

Drying Forage by Forced Ventilation, by Roy B. Davis, Jr., Leonard G. Schoenleber, and Lowell E. Campbell. Farmers' Bulletin No. 2028, U.S. Department of Agriculture, (Washington, D.C.) Presents considerations including weather hazards; advantages, disadvantages, and limitations of forced air drying; hay-drier systems; operation and management of the drier; and efficiency of harvesting.

Welded Wire Fabric for Farm Use. Design Manual No. FC-40, Wire Reinforcement Institute, Inc., (Washington, D.C.) Covers use in reinforcing concrete, dairy and cattle structures, feeding floors, paved yards, hog houses, water tanks, poultry applications, silos, grain storage, construction of houses, septic tanks, pump houses, soil conservation structures, concrete dams, irrigation ditches and canals, manure pits and shelters, livestock shade panels, and related information.

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN: JULY—0-301-529, AUGUST—0-320-533. SEPTEMBER—0-340-539, 353-540, 354-541, 355-542, 356-543. OCTOBER—0-401-544, 396-545.

POSITIONS WANTED: MAY—W-253-54, 276-56, JUNE—W-232-60, 263-65. AUGUST—W-310-69, 315-70, 292-71. SEPTEMBER—W-331-72, 333-73, 334-74. OCTOBER—W-383-76, 375-77, 391-78, 398-79.

NEW POSITIONS OPEN

ELECTRIFICATION ADVISORS (2), for electric cooperatives in Iowa. Work with educational agencies, dealers, electricians, and farmers to encourage proper installation, use, and maintenance of farm wiring and electrical equipment. Training in agricultural engineering, practical experience in rural electrification and farm background desirable. Good character references required. Excellent opportunity. Age, under 45. Salary open. 0-436-546

NEW POSITIONS WANTED

DESIGN, development, or research in power and machinery with manufacturer, preferably in Midwest or New England. Interested in opening with opportunity for some field work and for construction of prototype equipment. Mechanical engineering training in England and some farm background. Apprentice, mechanic, and assistant experimental officer in turn over 7-yr period at National Physical Laboratory, Teddington, England. Design engineer with steel company in Illinois 1947-48. Since 1948 mechanical engineer with U.S.D.I., Alaska Native Service, on mechanical installations in public buildings. Single. Age 28. No disability. Available on 6-week notice. Salary $4800. W-419-80

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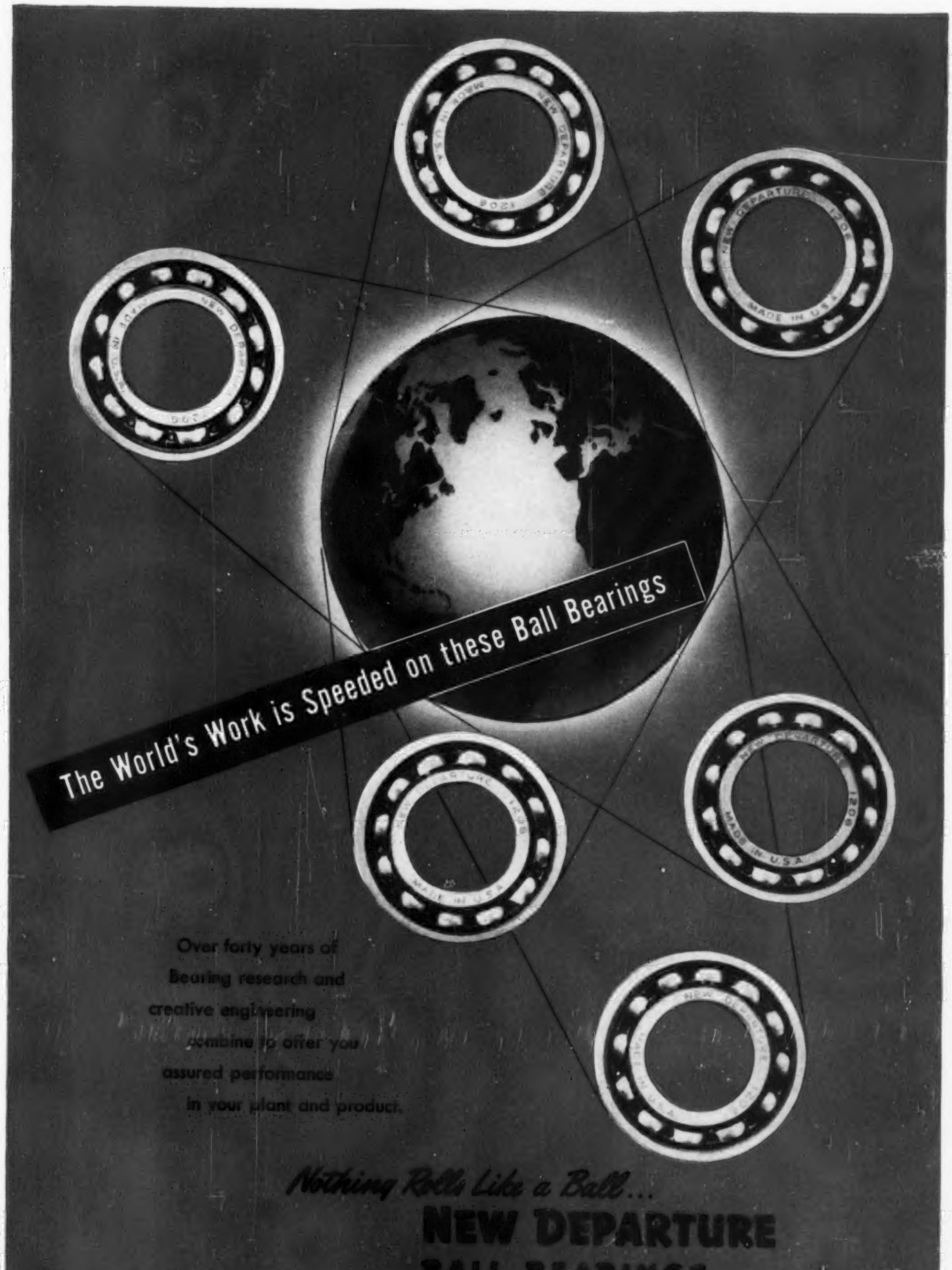
RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.



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